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1986 NATIONAL BUREAU OF STANDARDS AUTHORIZATION

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

FIRST SESSION

FEBRUARY 26, 28; MARCH 6, 1985

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*Ranking Republican Member.
**Serving on Committee on the Budget for 99th Congress.

CONTENTS

WITNESSES

Page

February 26, 1985:

Dr. D. Bruce Merrifield, Assistant Secretary of Commerce for Productivity, Technology and Innovation 7
Dr. Joseph F. Caponio, Director, National Technical Information Service .. 20
Dr. Ernest Ambler, Director, National Bureau of Stantards; Accompanied by Raymond G. Kammer, Deputy Director; Dr. John W. Lyons, Director, National Engineering Laboratory; James H. Burrows, Director, Institute for Computer Sciences and Technology; Dr. Donald R. Johnson, Director, National Measurement Laboratory; Dr. Lyle H. Schwartz, Director, Center for Materials Science 29

February 28, 1985:

Dr. Arthur E. Humphrey, provost, Lehigh University, Bethlehem, PA 172
Rollin "Pete" England, president, National Conference of Standards Laboratories, accompanied by H. Bryan Werner, executive vice president and George Rice, past president 179
Dr. Russell G. Meyerand, Jr., vice president, technology, United Technology Corp., Hartford, CT 187
Joseph O'Grady, executive vice president, American Society of Testing and Materials, Philadelphia, PA 203
John A Gosden, vice president, Equitable Life Assurance Society, New York, NY 220
William C. Connolly, president, National Conference of States on Building Codes and Standards, director, Division of Housing, Trenton, NJ 234
Thomas Moses, chairman of the board, National Institute of Building Sciences, Washington, DC 277

March 6, 1985:

Dr. Frederick Seitz, professor emeritus, Rockefeller University, New York, NY; Dr. William R. Prindle, director of administration, R&D Division, Corning Glass Works, Corning, NY; Dr. James Leonard, vice president of technology, Bethlehem Steel Corp., Homer Research Laboratory, Bethlehem, PA; and Dr. Steve Berry, Department of Chemistry, University of Chicago, Chicago, IL 304
Gordon H. Millar, Ph.D., former vice president of engineering, John Deere & Co., Moline, IL; Paul M. Fitzgerald, Factory Mutual Research Corp., Norwood, MA; Jordan J. Baruch, Sc.D., Washington, DC 476

APPENDIXES

APPENDIX I

STATEMENTS FOR THE RECORD

A. Dr. Lewis M. Branscomb, office of vice president and chief scientist, International Business Machines Corp 517
B. Dr. Peter Cannon, vict president-research and chief scientist, Rockwell International Corp 521
C. American Society of Civil Engineers 523
D. Computer and Business Equipment Manufacturers Association 530
E. Albert M. Navas, president, American National Metric Council 532
F. Dr. Ugo O. Gagliardi, Gordon McKay professor of the practice of computer engineering, Howard University 536
G. National Small Business Association 552
H. Edward Nemeroff, president, Datron Instruments 553

Page

APPENDIX II

Fire Research Program—Statements and letters 555

APPENDIX III

Center for Building Technology—Statements and letters 576

APPENDIX IV

Fire and Building Research Programs—Statements and letters 598

APPENDIX V

Institute for Computer Sciences and Technology, Statements and letters 615

APPENDIX VI

New Program Initiatives at NBS, Statements and letters 667

APPENDIX VII

Office of Productivity, Technology, and Innovation, Statements and letters 678

APPENDIX VIII

National Technical Information Service, Letters 688

APPENDIX IX

Additional questions and answers for the record 698

1986 NATIONAL BUREAU OF STANDARDS AUTHORIZATION

TUESDAY, FEBRUARY 26, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research and Technology,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:40 a.m., in room 2318, Rayburn House Office Building, Hon. Doug Walgren (chairman of the subcommittee) presiding.

Present: Representatives Walgren, Lujan, Ritter, Henry, Cobey, Brown, and Bruce.

Mr. **Walgren**. The meeting will come to order. I think we can proceed. Today the subcommittee begins its review of the administration's fiscal year 1986 budget request for the National Bureau of Standards and the Office of Productivity, Technology and Innovation. These are certainly, in our committee's view, two important components of the Department of Commerce that have been at the forefront of helping American industry compete in world markets. Yet under the administration budget submissions, both agencies are facing major budget changes, and in the case of Office of Productivity, Technology and Innovation, relatively absolute restructuring, if not elimination.

It is my hope that today, when we remain, particularly in the industrial sector, burdened with painfully high unemployment, and when on a national basis the trade deficit has literally spun out of control, that we will be able to focus on the contributions of these agencies and what these functions that have been carried out by these agencies in the Government have to contribute and what the expectations are if the budget cuts as proposed by the administration are implemented.

At the National Bureau of Standards, the cuts this committee rejected in the past years have simply been resubmitted. The Bureau's Center for Fire Research and its Center for Building Technology are once again slated for zero funding. And the Institute for Computer Sciences and Technology is scheduled for approximately a 50 percent cut.

Each of these functions, in the Bureau of Standards budget book, it is alleged, belong in the private sector. I can only say that the committee heard substantial testimony on that approach last year and found very little support for it, if any. It appears that we are simply going over the same ground that the committee did last year, and I think that's a very sad state of affairs. But if that's what the administration proposes, that's apparently what we will have to do.

We, of course, would be interested to know what preparations have been made over the past years for the transfer of these functions to the private sector and whether the administration plans to transfer to the private sector the unique facilities in the Bureau of Standards, particularly the Centers for Building Technology and Fire Research that we have built up over the years.

This year an additional 10 percent is lopped off the Bureau of Standards budget through cuts to overhead and by the elimination of working capital funds in the 1986 year. A 5-year plan to reduce the number of professional personnel at the Bureau by 10 percent would also go into effect.

We are aware that cuts of this magnitude will require the Bureau to make some very difficult choices that go well beyond what could be termed discretionary spending, and we also note that the Grace Commission, with a great focus on waste, examined the Bureau and found that there were literally no excesses to be cut.

The budget does permit the Bureau to begin construction of a building for its cold neutron source, to make modest improvements in its process and quality control programs, and to begin new initiatives in biotechnology and ceramics.

But these additions are relatively small in significance compared to the cuts, and where inflation is considered, operating funds received from direct appropriations will be down almost 15 percent in this year alone.

All of this seems slightly out of sync with the President's Commission on Industrial Competitiveness, which very recently has been lamenting the decline in our technology markets and has been calling for major strengthening of the Government's ability to aid the private sector in making the kind of progress that these functions in the Bureau of Standards are designed to promote.

The Bureau fared relatively well when compared, I am afraid, to the Office of Productivity, Technology and Innovation. OPTI is slated for elimination under these proposals by September 1986. We frankly don't understand that, and we had thought the administration placed a very high priority on building up the private sector and eliminating governmental barriers to competition and innovation. Certainly, internationally we need that, and we simply don't understand why the Department of Commerce's advocates of these policies are being essentially wiped out.

We certainly will be very interested to hear what proposals are made for those programs of recognized value that the Office of Productivity, Technology and Innovation has had responsibility for and whether they are simply to end as well.

[The opening statement of Mr. Walgren follows:]

OPENING STATEMENT
HONORABLE DOUG WALGREN
NATIONAL BUREAU OF STANDARDS AUTHORIZATION
FEBRUARY 26, 1985

TODAY WE BEGIN OUR REVIEW OF THE ADMINISTRATION'S FY 1986 BUDGET REQUESTS FOR THE NATIONAL BUREAU OF STANDARDS AND THE OFFICE OF PRODUCTIVITY, TECHNOLOGY, AND INNOVATION. THESE TWO IMPORTANT COMPONENTS OF THE DEPARTMENT OF COMMERCE HAVE BEEN AT THE VANGUARD OF HELPING AMERICAN INDUSTRY COMPETE IN WORLD MARKETS, YET BOTH AGENCIES ARE FACING MAJOR BUDGET CURTAILMENTS. IT IS MY HOPE THAT TODAY, AT A TIME WHEN UNEMPLOYMENT IN THE INDUSTRIAL SECTOR REMAINS PAINFULLY HIGH AND WHEN OUR TRADE DEFICIT IS OUT OF CONTROL, WE WILL BE GIVEN A GOOD EXPLANATION AS TO WHY THESE CUTS ARE BEING PROPOSED TO HAPPEN.

AT NBS, THE CUTS THIS COMMITTEE REJECTED IN PAST YEARS HAVE REAPPEARED. NBS'S CENTER FOR FIRE RESEARCH AND ITS CENTER FOR BUILDING TECHNOLOGY ARE ONCE AGAIN SLATED FOR ELIMINATION AND ITS INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY IS ONCE AGAIN SCHEDULED TO BE CUT IN HALF. EACH OF THESE FUNCTIONS, THE NBS BUDGET BOOK CLAIMS, BELONGS IN THE PRIVATE SECTOR, SO WE WILL BE INTERESTED IN LEARNING WHAT PREPARATIONS HAVE BEEN MADE OVER THE PAST YEAR FOR THE TRANSFER OF THESE FUNCTIONS AND WHETHER THE ADMINISTRATION PLANS TO TRANSFER TO THE PRIVATE SECTOR NBS'S UNIQUE FACILITIES SERVICING THESE INDUSTRIES.

This year an additional ten percent is lopped off NBS's budget through cuts to overhead and by eliminating additions to the Working Capital Fund for 1986. A five-year plan to reduce the number of professionals at the Bureau by 10% over five years would also go into effect. We expect that cuts of this magnitude will require the Bureau to make some very painful choices that go well beyond discretionary spending. After all, the Grace Commission carefully examined the Bureau and found no fat to be cut.

The Budget does permit the Bureau to begin construction of a building for its Cold Neutron Source, to make modest improvements in its Process and Quality Control program, and to begin new initiatives in biotechnology and ceramics, but these additions pale in significance to the cuts. Where inflation is considered, operating funds received from direct appropriations will be down approximately 15% in just one year. All of this seems slightly out of sync with the President's Commission on Industrial Competitiveness which this very month has been lamenting our decline in 7 of 10 high technology markets and has been calling for a major strengthening of the government's ability to aid the private sector as it struggles to meet stiff competitive challenges from overseas.

However, the NBS fared well when compared to the Office of Productivity, Technology, and Innovation. OPTI is slated for elimination by September 30, 1986. We have not been told why this is happening and frankly we're puzzled. We had thought that the Administration placed a high priority on building up the private

SECTOR AND ELIMINATING GOVERNMENTAL BARRIERS TO COMPETITIVENESS BOTH DOMESTICALLY AND INTERNATIONALLY. WE DO NOT UNDERSTAND, THEREFORE, WHY THE COMMERCE DEPARTMENT'S ADVOCATES OF THESE POLICIES ARE BEING ELIMINATED. WE INTEND TO ASK DETAILED QUESTIONS REGARDING HOW OPTI'S ELIMINATION WILL AFFECT THE IMPLEMENTATION OF THE STEVENSON-WYDLER ACT, THE METRIC CONVERSION ACT, AND THE BAYH-DOLE ACT AND WHERE THESE FUNCTIONS WILL BE TRANSFERRED.

I, THEREFORE, WISH TO WELCOME OUR DISTINGUISHED GROUP OF GOVERNMENT WITNESSES TODAY FOR WE LOOK FORWARD TO YOUR EXPLANATIONS OF THE RATIONALE BEHIND THE ADMINISTRATION'S PROPOSALS IN THE AREAS YOU MANAGE.

Mr. WALGREN. With that as an opening statement, the Chair would recognize other members if they would like to make opening comments.

Mr. Ritter.

Mr. RITTER. Thank you, Mr. Chairman.

I would like to start out by saying that the United States is in a race for its technological life, so to speak, and that race is under way today and it will continue well into the 21st century. Many of us, myself with many colleagues, have been trying to foster the climate for industrial competitiveness and U.S. resurgence in the world economy, and one of the features that we have been interested in is the greater linkage between the Nation's R&D resources, particularly those Federal R&D resources, and the competitive world, the industrial world. And I would like to commend the record, the track record, of the National Bureau of Standards in this regard.

There is no doubt in my mind that amongst all of the Federal research establishments, the National Bureau of Standards, perhaps because of its original missions, has probably done more to couple the great Federal R&D resources that they have with the private sector than any institution under the aegis of the Federal Government. It would seem to me that because of that kind of leadership in bringing Federal R&D resources more closely to the problems of industry, and really vice versa, that we should be commending in some way the National Bureau of Standards at budget time.

My record for fiscal responsibility is as clear as anyone's in the Congress, but I don't think we should, in order to save a certain number of dollars, be doing away with the Nation's seedcorn. And I think that some of these approaches to the National Bureau of Standards amounts to destroying seedcorn.

Now, we're talking about 6 years, basically 6 years of personnel and budget decline, in the face of the fact that NBS was leading the way amongst Federal laboratories in supporting industrial competitiveness. We're talking about robotics, materials, the nondestructive evaluation for process control, analytical chemistry. NBS led the way in cooperative efforts with industry, which is what some of us are desperately trying to do with other Federal research and development establishments, and frankly have met to date with limited success. NBS is already doing it.

I would like to point out that NBS has programs of industry-federal lab cooperation which are largely and heavily supported by industry. There are 160 industry scientists and engineers, there is industry equipment, guest workers from universities and other support. We're talking about a major hunk, maybe nearly half of the NBS expenditures, are actually coming from hustling with industry or providing services for other Federal organizations.

Why we would take this budget and emasculate it is really beyond me. NBS is really a high-tech agency. And that's really what we want. I have got some other ideas as to what the problems are surrounding NBS, and it is probably—the major problem—is probably its location in the system. It's a stepchild of the department, who doesn't know that much about it and probably doesn't really care too much for it. And maybe we should be doing something about that, Mr. Chairman.

I think the decline—the blood flow has to be stanched, the decline has to be stopped, and I think we have to recognize from a scientific and technological perspective what the contributions are of this organization, and act accordingly.

I think at the worst NBS should at least be allowed to keep up for inflation and some modest growth in those areas which we wish to focus on. They've done what we're trying to do, and here we are—my administration, actually—is in a position of emasculating them. Well, I for one don't go along.

Thank you, Mr. Chairman.

Mr. WALGREN. Thank you, Mr. Ritter.

Mr. BROWN. Mr. Chairman, I was just wondering if we couldn't go directly to markup after those eloquent remarks and save ourselves a little time here. [Laughter.]

Mr. WALGREN. Well, the Chair would certainly entertain any motion to resubmit last year's testimony in support of the various programs, and I think we would be able to go to markup relatively directly on the basis of that evidence.

Do any of the other members have opening statements?

[No response.]

Well, I would like to invert the order of testimony here. Dr. Merrifield, if I could ask you to come forth first. I understand you have some time constraints.

I apologize for our late start. If you, Dr. Caponio, would come and join, we will begin.

As you know, Dr. Merrifield, written statements will be made part of the record, and we would be pleased to hear your views of where we are and what we have accomplished and what we should be doing. We look forward to that from you, Dr. Merrifield.

STATEMENT OF DR. D. BRUCE MERRIFIELD, ASSISTANT SECRETARY FOR PRODUCTIVITY, TECHNOLOGY AND INNOVATION

Dr. MERRIFIELD. Thank you, Mr. Chairman. The first point that I think we need to make clear is that we're all very urgently interested in reducing the budget deficit and that we all have to contribute our share. To the degree that this no longer allows some of the functions to continue at their present level, then the administration and the Department of Commerce are working to transplant those capabilities into other agencies where appropriate skills and capabilities would exist, and to maintain then a sort of super-coordinating function that would try to integrate those capabilities throughout the administration.

I think we've been very strongly supportive of the Stevenson-Wydler Act, sometimes creatively we actually have tried to exceed the spirit and the intent of that law. And I think we've made some fairly good progress. I think that is sort of delineated in the written statement.

Beyond that I would like just to answer questions that you might have.

[The prepared statement of Dr. Merrifield follows:]

Statement of

D. Bruce Merrifield

Assistant Secretary of Commerce

For

Productivity, Technology and Innovation

Before the Subcommittee on Science, Research and Technology

of the

House Committee on Science and Technology

February 26, 1985

Mr. Chairman:

We are proposing authorization for the Office of Productivity, Technology, and Innovation, or OPTI, of $1,762,000 in FY 1986 compared to $2,335,000 in FY 1984 and $2,460,000 in FY 1985. The money for fiscal 1986 is to be used for a phase out of OPTI to a small executive staff of about three people beginning in fiscal year 1987.

We believe that termination of OPTI is appropriate now since it has successfully completed its major tasks, specifically:

- By the passage of the National Cooperative Research Act of 1984, a major antitrust barrier to cooperation in R&D among U.S. companies has been removed;
- OPTI's Industrial Technology Partnerships Program has helped to stimulate over $2 billion of private sector R&D financing through the use of research and development limited partnerships (RDLPs) in the last three years, compared to only $200 million in 1981; and
- OPTI's Federal Technology Policy program succeeded in drafting and obtaining approval of a Presidential Memorandum that makes contractor ownership of inventions government-wide policy. OPTI also helped to draft provisions that were included in P.L. 98-620, which extends the principle of contractor ownership to some of the largest government-owned, contractor-operated laboratories.

I will continue to work to strengthen the contribution of technological innovation to U.S. competitiveness, economic growth and new job formation. Following are some examples of specific activities that we would expect to continue within the limits of my resources: we will function as the Department's focal point and advocate on policy matters involving productivity, technology and innovation; we will assist the private sector to form cooperative R&D ventures, especially in leapfrog technologies where the R&D efforts cut across traditional industry lines and where Federal laboratories can contribute expertise; and we will continue to foster international cooperative R&D ventures between U.S. and developing nation companies based on the very successful BIRD Foundation model with Israel.

The National Technical Information Service (NTIS) will continue to report to me. Self-funding, information clearinghouse activities facilitate the transfer of technology to U.S. firms and are of crucial importance in enhancing the ability of U.S. business to compete more effectively in world markets. Dr. Caponio, the Director of NTIS, is here today. He will describe several proposals for technical changes to the NTIS organic legislation which will permit it to be even more efficient and effective in carrying out its important mission.

In conclusion, Mr. Chairman, I would like to emphasize that this Nation's continued leadership in the field of technological innovation is critical to our economic growth, the development of sustainable new jobs, and the competitiveness of our industry internationally. We must recognize that more than two-thirds of U.S. industries--whether actually involved in exports or not--now compete in world markets. A simple, yet often overlooked, point is that when a U.S. manufacturer sells his product to someone in the U.S., he is, in fact, competing not just in the U.S. market but in the world market. To regain and maintain world leadership, the United States must capitalize more effectively on its natural advantages, especially its great breadth and depth of scientific research and its unparalled entrepreneurial culture. To do this, we must continue to remove barriers and provide incentives for increased productivity and innovation, and to catalyze cooperative efforts.

Thank you, Mr. Chairman. I will be happy to answer any questions.

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Productivity, Technology and Innovation
Washington, D.C. 20230
(202) 377-1984

BIOGRAPHICAL DATA

D. BRUCE MERRIFIELD

Dr. D. Bruce Merrifield is a graduate of Princeton University and holds Masters and Doctoral degrees in Physical Organic Chemistry from the University of Chicago.

Dr. Merrifield has since been in research, research administration and new venture management and is currently Assistant Secretary of Commerce for Productivity, Technology and Innovation. Formerly, he was Vice President of Technology and Venture Management for The Continental Group.

He is a former Director and president-elect of The Industrial Research Institute; he also has been Chairman of the Board of The IRI Research Corporation and is a former Trustee and Chairman of the Research Council of The American Management Association. Currently, he is a member of The Directors of Industrial Research, a member of Sigma XI Honorary Society, and is a Fellow of both The American Association for Advancement of Science and of The Institute of Chemists.

Dr. Merrifield also has been a member of the Advisory Board for the Binational Research and Development Foundation with Israel and of the U.S. Department of Commerce's Trade Mission to the People's Republic of China. He has served both as Science Advisor to the Jordanian government and as a member of one of the Department of Defense transition teams.

Dr. Merrifield also has been active in community affairs as a former Chairman of the Board of Education, a Trustee of several schools, as National Chairman of the Princeton Alumni Association, a board member of several foundations, and a member of the Executive Council of the Episcopal Church.

Mr. **Walgren**. As you know, Dr. Merrifield, you have enjoyed a great deal of respect from Members of Congress for the interest and commitment and talent that you brought to your position in the Office of Productivity, Technology, and Innovation, and we are particularly disappointed (knowing that there was somebody of your stature involved in that area) to see the area divided up and perhaps that effort stopped.

Let me ask you this. Looking back on the range of OPTI activities, what percentage of them would be effectively transferred to other centers of activity and continued with the same relative strength and effectiveness that you have seen under your administration of OPTI as an individual entity?

Dr. **Merrifield**. Well, that's difficult to answer right at the present time because we're still working on the way in which that would happen. However, I think that, for example, the patent policy function might visibly go into the Patent Office, the small business development work that we've been doing might go into the Small Business Administration, in whatever manner that structures itself eventually. The national technology medal, for example, might find a home in the National Bureau of Standards.

There are obvious thoughts along this line that we would be pursuing, and what I would try to do would be to maintain the overview and the coordination between those agencies to make sure that the appropriate skills would be available.

What we've developed in OPTI, of course, is our set of specialized skills that can be then perhaps transplanted into these other agencies to continue that work under some sort of overview.

Mr. **Walgren**. The question I would have is that to the degree that those functions are transferred and effectively conducted, we save no money.

Dr. **Merrifield**. Well, that's true in one sense. On the other hand large agencies do have some attrition, and it might be possible to substitute these for others and reduce the total budget. I think that's the concept. And to the degree that that's successful, we'll have to wait and see. But that's how the thing is presently planned.

Mr. **Walgren**. But you would agree, would you not, that to the degree that these functions are picked up and transplanted, the budget deficit is really not helped; that attrition that they conceive of would be available for reductions in those other agencies with as much effect on the budget deficit as this.

And so the real question comes down to whether or not these activities were, on balance, making a positive contribution to our economy and whether they are good present and future investments aimed at literally our most critical problem these days, which would be the hemorrhage in the trade balances of this country? Would you not feel that what you've undertaken under your administration made a valuable contribution to that?

Dr. **Merrifield**. Well, I certainly would like to hope so. I think that there are quite a number of things that we have undertaken. I believe the changes in the antitrust laws that we have worked together on are landmark pieces of legislation in the sense that they're beginning to stimulate tremendous collaborative efforts now on a large scale, much more than people realize.

I think that it takes a little while; there is an induction period involved. But those are now coming along in ceramics and biogenetics and all sorts of things.

Mr. **WALGREN**. If I might underscore the value of that contribution, many in my community were very surprised that the Congress had moved as directly as it had on patent law reform. I attribute more than the lion's share of the credit for that to the organizational structure that you had in OPTI that allowed someone like you to come to the Congress recommending changes like that. Once the administration is in the position of being supportive of these kinds of changes, the Congress is literally enabled to pick up on them. We find it difficult to do it by ourselves because of the internal division that naturally occurs.

I am concerned that if you don't have a narrowly focused office with these particular values and this particular purpose, these changes could never make it through the recommendation process of a larger bureaucratic organization. They would get stymied or paralyzed three-quarters of the way up the ladder, and then it would never get over to the Congress to be presented and to be picked up. Do you feel that that's an unfair assessment of the circumstances we face?

Dr. **MERRIFIELD**. Well, we've seen ourselves to be a catalytic agent of change that does identify the critical issues and does try to initiate collaborative efforts not only within the Department of Commerce but with other agencies as well, to build the sort of support, the policy support, for these changes that we think are helpful. And that policy, or that function, hopefully, will continue, but in a different fashion.

Mr. **WALGREN**. My point is that I am very skeptical whether that function can continue if those, with this focus, are transferred into larger bureaucracies and different bureaucracies as well. I think the history of past experience would be that they will not surface in terms of their presentation to the Congress, that there will be blocks within that larger bureaucracy that will prevent that clarity of thought and direction from coming through.

Dr. **MERRIFIELD**. Well, that's a good point. I think that it takes positiveness and persistency to make those things happen. Of course, that would be my intent, and the administration feels that that is a possibility.

Mr. **WALGREN**. I don't know. Well, ultimately, it is the Congress' responsibility to decide these things, and that at least is, I think, some cause for hope. We are trying to weigh the judgment of those who drove this kind of recommendation against the value of the programs as we can appreciate them through the evidence that we hear. I do believe that the Congress does appreciate the investment that can be made through this kind of effort.

Let me ask you on behalf of Parren Mitchell, and with the consent of the other members of the committee, I would like to make a part of the record a letter we have received from Congressman Mitchell inquiring specifically about the disposition of the small business activities and focus of OPTI if the administration's plan to eliminate OPTI is adopted by the Congress. I would like to make that letter part of the record.

[The letter follows:]

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MAJORITY—225-5821
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AREA CODE: 202

February 25, 1985

Honorable Doug Walgren
Chairman
Subcommittee on Science Research &
Technology
Committee on Science and Technology
U.S. House of Representatives
2319 Rayburn H.O.B
Washington, D.C. 20515

Dear Doug:

As you are aware, the Department of Commerce has established a small business unit within the Office of Productivity Technology and Innovation (OPTI). The Administration has proposed its elimination. Because OPTI is emerging as a lead agency for innovation policy within the Federal government, it is vital that OPTI maintain a sensitivity to small business and the role small business plays in technological innovation.

Small innovative firms have special needs that are not always recognized or addressed in the programs and policies of the Department of Commerce. A small business office, therefore, performs an important function and should be maintained.

The decline in industrial innovation in the United States has been a matter of considerable concern to the Small Business Committee and prompted me to support the establishment of such an office on the basis that it would serve the Department mission and objectives.

Once again, I respectfully request that consideration be given to the special functions of this small business unit and that funds be authorized for its continuance.

Small firms are the nation's leading innovators but are not always able to marshal the forces necessary to enable them to bring new technologies and processes to commercialization. The existence of a small business office in this important agency can enhance the innovative capacity of small entities, and increase the nation's competitiveness in world markets.

In your Committee hearings and deliberations, I would hope that you take the opportunity to ask the Assistant Secretary for Productivity, Technology and Innovation about critical elements of the program and its small business activities and objectives.

I sincerely appreciate your consideration of this matter.

Sincerely,

Parren
Parren J. Mitchell
Chairman

PJM:lff

Mr. **Walgren**. Dr. Merrifield, if you could respond with your understanding of what the disposition of those functions of OPTI would be.

Dr. **Merrifield**. Well, that's a good question. I think we see the small business community as being one of the most vital areas of all. As you know, I feel that we have pretty good evidence that we have a small business bottom-up entrepreneurial revolution going on in this country. There were 600,000 new companies formed in 1983, 650,000 or thereabouts in 1984, and that's where 90 percent of the 7 or 8 million new jobs that have been created in the last 2 years have been formed.

Basically, I think the catalytic efforts that allow this to continue could be very vital to our economy and continue to help our economy grow at a high level with very low inflation because of the enormous productivity increases that are associated with innovation and with automation that's occurring now.

The point is that what what we've been doing is to bring in key people from the small business development centers to get them up to speed in terms of how to run and identify projects. We have a constraint analysis that we teach these people that achieves about 8 or 9 out of 10 successes instead of maybe 1 out of 20 commercial successes. Also we have a computer simulation technique that helps to quantify the critical factors that are involved in a given operation.

We have an intern program in Commerce into which we've been bringing these people to teach them how to do this; also people from universities and the Government laboratories to do the same thing.

What we're trying to do is plant this competence in the private sector, in the Government laboratories and in the small business development centers so that they can sustain this capability on their own. It's a catalytic effort, and I think that we will make continued progress this year.

Of course, another major effort that we're making is to set up incubator centers in concert with State and local governments, based essentially around flexible manufacturing core production facilities that will be the entrepreneurial focus in local areas. The Department of Defense, the strategic mobilization people are very much interested in working with us. They see this as a surge capacity in case of national emergencies as well as a way to reduce inventories of parts and so forth.

But I think again that we can accomplish much of that in the very near future, and once we have this started, it should be self-catalytic.

Mr. **Walgren**. And then what happens if the thing comes to an end?

Dr. **Merrifield**. Well, I think what we're trying to do is make it self-perpetuating by planting it in the private sector in a lot of different places so it can be self-growing and developing. We're working with some of the private laboratories like Stanford Research Institute and Battelle and A.D. Little and so forth to develop that competence; also with universities and engineering schools to develop the competence to teach these same concepts there. We hope to plant this competence so that it can multiply by itself without further help from us. That's our intent.

Mr. **Walgren**. Yes. Let me ask you about what I personally feel is one of the greatest contributions individually I have seen made by someone serving an administration, and that is the encouragement of the use of limited partnerships in R&D financing. Can you just give us a brief description of our progress there and what you anticipate to happen to that if OPTI is gone?

Dr. **Merrifield**. Well, again, that was a "creative response" to the Stevenson-Wydler proposal to set up generic research centers. Actually, it's been more successful than we had expected, and there have been about $2.5 billion worth of these formed or funded, primarily for small businesses. Until the antitrust laws were changed, the primary use of those was in small businesses. As you know, we issued guidelines for how to do this, and we've put together a consortium of financial houses—the E.F. Huttons, the Merrill-Lynches, the Prudential-Baches, the Morgan-Stanleys and so forth—who have developed big pools now, $25-$100 million pools of money to invest in limited-partnership projects. So that's a beginning toward being self-sustaining. I think it can be autocatalytic in a sense, and, hopefully, it won't need a great deal more stimulus.

There are ambiguous items in the tax laws that probably need to be clarified. We're working to try to identify the options there so that we can suggest legislation that might improve the situation. But again I think much of that can be accomplished in this year.

Mr. **Walgren**. It certainly seems to me that that's an example of an area of progress that reasonable people would conclude would not have happened but for the push that you were able to give it through the standing that you have as the administrator of OPTI and your personal interest in it and your recognition of the potential there.

Certainly, that area was as autocatalytic prior to your involvement with OPTI as it is now, and I for one would not want to see as little happen in the future as was happening before you came to OPTI in that area. I personally feel that that is an individual contribution of substantial dimension that was enabled because we had an OPTI and because there was somebody like yourself with the appreciation of what was possible there. I think we will be the poorer if we don't have an OPTI and if we don't have somebody like yourself able to make that kind of contribution.

Well, let me recognize the gentleman on my left, Mr. Ritter.

Mr. **Ritter**. I think I am on your left in physiological terms only, Mr. Chairman. [Laughter.]

We have a long history of working together.

Dr. Merrifield, I would like to commend you on the work that you've done in this small organization. I think it's proof positive that it's not money you throw at a problem, but it's the ideas and the perseverance and the commitment and the teamwork that you can generate to help solve it. I think there's no doubt about it, and I think you've proven that.

I guess my thought is that when you have something that's so successful and that has leveraged so much out of the system, and it frankly is along the lines that so many of us have been promoting—that is, to open up the system so that freedom and enterprise and that energy that's out there can burst forth and make us leaders again in technology and in the application of technology in the marketplace—I see no less challenge out there.

In fact, you know, once you've been a little bit successful, then you can take on even more. Certainly, the barriers are there. They're there, and they're enormous. Breaking down those barriers—I serve as vice chairman of a 137-member high-tech task force along with Ed Ciao from California, Lehigh Valley manufacturing America, Silicon Valley high-tech America—we see so many barriers to the building of this new technological base to America.

We don't see many people around this town who understand it the way you do, who has got a good track record in, you know, slaying the Goliaths. Why put you on such a diet? [Laughter.]

Dr. MERRIFIELD. Well, maybe there's a lot of confidence in my catalytic efforts. [Laughter.]

I think that the perception now is that many of the objectives that we sought—removal of barriers, provision of incentives, and identification of critical data and information to catalyze these activities—have been accomplished, and that these efforts can be reduced without significant loss.

Mr. RITTER. Well, I don't know where that theme is coming from, but to my way of thinking, the battle has just been joined. We haven't won it. We have, you know, just begun to fight. We're at the beginning, I think, of not just the science base of this technological revolution, but the way the society is able to use it and to enhance the flow of it into a variety of areas which enhance our competitiveness and our quality of life. We learn to live with modern technology and live with it much more efficiently, particularly when it comes to the Federal Government not being the block, but being at some point in the system a stimulus.

I can certainly sit down with you and spend 3 hours on obstacles that are out there that we should be dealing with on changes that should and must be made to get far greater bang for the buck of Federal investments in R&D to be able to privitize parts of this massive R&D economy in a way that keeps it more focused on products and markets and processes.

I mean there are so many challenges out there. There is the challenge that you use some of your own ideas—I am not sure, no one is sure, what's happening with the tax system—but we know darn well that the relationship between universities and industry can be made far better and far more direct if it doesn't have big Federal agency interventions all over the place. And you've got a lot of ideas there that could be put into the process.

I mean I think we've just started to somehow come up with the idea—I know it's probably not coming from you—but coming up with the idea that the job is done. I mean we're out to change the system—and you've done a good job in your first few years—why should we go back to the old system by dismantling the kinds of things that you have been doing? Again, I can provide you with far more work than you could possibly accomplish. I am sure you've got it on your own agenda.

There is something strange about treating success in a way that punishes it as opposed to rewards it. But I will leave that for future generations of speakers.

I yield back, Mr. Chairman.

Mr. **Brown** [presiding]. Mr. Henry.

Mr. **Henry**. Thank you, Mr. Chairman.

I guess I am new, and I am the first to admit to being new around here. But I am kind of struck by the fact that in terms of legislative parallels, if I had an agency director that was upset with what was happening, he'd say so rather than read his testimony with a smile. [Laughter.]

You have consistently been smiling. Are you really smiling inside?

I just spent yesterday afternoon—with all the things asked to read, as you know, most of us throw out 90 percent of the stuff we're asked to read—I read the volume 1, which is the easier of the two volumes of the Technology Task Force Report. They're talking about strengthening the very kinds of things your offices render, talking about establishing a department-level science and technology, to push this much harder. And now we're allowing this, you know, little effort to wither.

I am sorry, Mr. Chairman, I don't even know what the norms are around here to try to find out what a person believes and what he's been told to say, but I have a feeling I smell a rat. [Laughter.]

So maybe at this point, prudence is the better part of valor. But I have shown my hand on this thing, and I guess I really agree with the previous gentleman's comments as well that it just doesn't make sense, given what the needs of this country are, where we're hoping to move, and what the rhetoric of the administration is in terms of where it seeks to lead us.

Mr. **Brown**. Mr. Cobey.

Mr. **Cobey**. I have no questions. Thank you, Mr. Chairman.

Mr. **Brown**. Dr. Merrifield, I think you recognize that we all hold you in high esteem and are a little puzzled about your testimony. You've almost set a first here. I think you're the first assistant secretary who has come in and recommended the abolition of his basic function, and that should qualify you to be the secretary of some of the departments that the administration is trying to get rid of. [Laughter.]

Did you recommend that OPTI be abolished, as I assume you did? Did you submit a plan for the taking over of these functions, the distribution of them and so on?

Dr. **Merrifield**. The plan is in process of being worked out. The budget for 1986 would allow OPTI to operate at the present level but then the rest of the 1986 would be the transfer and changes that would occur. But those haven't all been worked out in detail.

Mr. **Brown**. I am surprised that you would submit a proposal without a plan to implement it. I am really trying to goad you a little into saying that you didn't really submit the proposal but that it was submitted to you. Would you care to discuss that question a little bit?

Dr. **Merrifield**. Well, I am here at the discretion of the President, and the administration position is that we need to cut the budget, and we all share in that. The need then is to focus on the priorities that are perceived to be most important. And the perception is that this is one area where we can reallocate the effort effectively and still maintain the catalytic function.

Mr. **Brown**. You recognize, of course, that there is a certain inherent contradiction in some of what you've said. You've recommended or you've indicated that you are proposing to recommend that, for example, the small-business functions be added to the Small Business Administration and the administration is recommending that that be abolished.

Dr. **Merrifield**. Well, that's again why a plan isn't possible at this point until some of those things are worked out. If the Small Business Adminsitration does disappear, why, then that would be another matter.

Mr. **Brown**. You have indicated that what's basically left of your function is the direction of NTIS. Is that correct?

Dr. **Merrifield**. Yes, NTIS is a self-funding operation and would continue. The remaining catalytic function would coordinate policy functions in the Department of Commerce.

Mr. **Brown**. Well, that's a tribute to your well-recognized abilities as assistant secretary, you can carry out these catalytic functions essentially without a staff.

I don't think we need to belabor this any further, Dr. Merrifield. If you have any pressing time demands, we'd be glad to excuse you at this time.

Dr. **Merrifield**. Thank you, Mr. Chairman.

Mr. **Brown**. We will hear at this time from Dr. Caponio.

STATEMENT OF DR. JOSEPH F. CAPONIO, DIRECTOR, NATIONAL TECHNICAL INFORMATION SERVICE

Dr. **Caponio**. Thank you, Mr. Chairman. If I may, with your permission, I would like to read a very brief summary of my statement.

Mr. **Brown**. Please do.

Dr. **Caponio**. Mr. Chairman, and members of the subcommittee, thank you for this opportunity to discuss the programs of the National Technical Information Service to request the authorization of appropriations for NTIS for fiscal years 1986 and 1987, and to request changes to our organic legislation.

NTIS serves as the primary source for the public sale of government-sponsored research and engineering reports, reports on federally sponsored research in progress, machine processed data files, and computer programs. As this central source, NTIS provides a full array of information products and services designed to encourage wider use of technology. In fiscal year 1984 NTIS acquired and made available approximately 72,000, including 21,000 foreign, new government-sponsored research and engineering reports. We sold approximately 490,000 copies of technical reports in paper form and 2,500,000 in microfiche, and fully recovered by revenue from sales, the costs of providing information products and services, which were in excess of $30 million.

Mr. Chairman, the NTIS clearinghouse operations are 100 percent self-supporting. However, there is one particular program within NTIS that receives appropriated funds. Our patent licensing program is the government's most active patent licensing program in terms of numbers of license and royalties received. We evaluate new technologies developed within Federal laboratories to identify inventions with possible commercial potential and promote selected inventions to U.S. industry.

In 1984 the program successfully negotiated 36 patent licenses, including 14 exclusive licenses, collected receipts of over $800,000; and paid cash incentive awards to 96 Federal employee inventors. Receipts collected under patent licenses currently exceed the cost of the licensing activity. Although NTIS charges and retains fees to partially cover the direct cost of licensing, royalty receipts (of $834,000 in 1984) are returned to the United States Treasury. Therefore, an annual appropriation is required to fund the program.

Appropriated funding for the program was $502,000 in fiscal year 1984 and $545,000 in fiscal year 1985. We request an authorization of $537,000 for fiscal year 1986, and $502,000 for fiscal year 1987.

Mr. Chairman, lastly I would like to discuss two requested changes in NTIS enabling legislation as presented in the NBS authorization bill submitted by the administration for fiscal year 1986 and fiscal year 1987. Section 4(a) of the proposed legislation would enable NTIS to obtain printing services from sources other than the Government Printing Office. This would reduce time in obtaining print stock to fill orders, allow us direct control over quality in printing, and reduce costs.

Section 4(b) of the proposed legislation would give NTIS explicit authority to acquire capital equipment and inventories from receipts. In a recent review by the General Accounting Office, we were advised that our current authority does not specifically permit the acquisition of capital assets. Therefore, we are requesting specific language be added to our organic legislation that would authorize capital asset acquisition or replacement.

That concludes my statement, Mr. Chairman. I would be happy to answer any questions.

[The prepared statement of Mr. Caponio follows:]

U.S. DEPARTMENT OF COMMERCE
STATEMENT OF JOSEPH F. CAPONIO
DIRECTOR, NATIONAL TECHNICAL INFORMATION SERVICE
BEFORE THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

FEBRUARY 26, 1985

Mr. Chairman and Members of the Subcommittee.

Thank you for this opportunity to discuss the programs of the National Technical Information Service (NTIS), to request the authorization of appropriations for NTIS for fiscal years 1986 and 1987, and to request changes to our organic legislation.

The NTIS enabling legislation, which was passed in 1950, (15 U.S.C. 1151-1157) directs the Secretary of Commerce to establish and maintain within the Department of Commerce a clearinghouse for the collection and dissemination of scientific, technical and engineering information. Section 3 of the Act requires that costs of the clearinghouse be paid from sales income, not from tax-supported Congressional appropriations. In 1970, NTIS was established as a primary operating unit of the Department to serve as that clearinghouse. NTIS makes domestic and foreign Federal technological, scientific, economic and engineering information accessible to business, industry, government, and other interested individuals and organizations. Use of the technological information that NTIS disseminates serves to: improve the economic health and growth of U.S. business and industry; increase productivity and innovation in the U.S.; improve the competitive position of U.S. firms in the world marketplace; and promote the use of foreign research results by U.S. industry.

NTIS serves as the primary source for the public sale of Government-sponsored research and engineering reports, reports on Federally-sponsored research in progress, machine-processed data files, and computer programs. As this central source, NTIS provides a full array of information products and services designed to encourage wider use of technology. In FY 1984 NTIS:

- o Acquired and made available approximately 72,000 (including 21,000 foreign) new Government-sponsored research and engineering reports.
- o Sold approximately 490,000 copies of documents in paper form and 2,500,000 in microfiche.
- o Fully recovered by revenue from sales the costs of providing information products and services which were in excess of $30,000,000.

Mr. Chairman, the NTIS clearinghouse operations are 100 percent self-supporting. However, there is one program within NTIS that receives appropriated funds.

PATENT LICENSING

Our Patent Licensing Program is the Government's most active patent licensing program in terms of numbers of licenses and royalties received. We evaluate new technology developed within Federal laboratories to identify inventions with possible commercial potential and promote selected inventions to U.S. industry. Our foreign filing activity assures the protection of U.S. Government-owned technology from unrestricted, uncompensated use by foreign competitors of U.S. industry. In FY 1984 the program successfully:

- Negotiated 36 patent licenses including 14 exclusive licenses.
- Collected receipts of $839,000
- Paid cash incentive awards to 96 Federal employee-inventors.

The program has demonstrated that patent licensing is an important mechanism for transferring technology from Government laboratories to the private sector. Under licenses granted, licensees pledge millions of dollars of private investment in R & D and new plant construction, creating new products, businesses and jobs. Receipts collected under patent licenses currently exceed the cost of the licensing activity. Although NTIS charges and retains fees to partially cover the direct cost of licensing, royalty receipts (of $834,000 in 1984) are returned to the U.S. Treasury. Therefore an annual appropriation is required to partially fund the program.

Appropriated funding for the program was $502,000 in FY 1984 and $545,000 in FY 1985. For FY 1986 we request an authorization of $537,000.

CHANGES TO ORGANIC AUTHORITY

Mr. Chairman, I would like to discuss two requested changes in NTIS' enabling legislation as presented in the NBS Authorization Bill submitted by the Administration for FY 1986 and FY 1987. Section 4(a) of the proposed legislation would permit NTIS to obtain printing services at the most economical rates possible. While we envision most of NTIS's printing requirements would still be met through the Government Printing Office, the proposal would offer the flexibility of having printing done elsewhere. The result would be improved control for NTIS over scheduling of production, better quality control, and lower costs. The result for the NTIS customer would be a more timely, higher quality product at lower prices. Section 4(b) of the proposed legislation would give NTIS explicit authority to acquire capital equipment and inventories from receipts. In a recent review by the General Accounting Office, we were advised that our current authority does not specifically permit the acquisition of capital assets (equipment and inventories). NTIS' current authority (15 U.S.C.1153) states that "... the services and functions provided therein shall be self-sustaining or self-liquidating and that the general public shall not bear the cost of publications and other services which are for special use and benefit of private groups and individuals...". Therefore, in order to fulfill our mission and to meet GAO's requirements, we are requesting specific language be added to our organic legislation that would authorize capital asset acquisition or replacement.

That concludes my statement, Mr. Chairman. I shall be happy to answer any questions you might have.

Mr. BROWN. Thank you, Dr. Caponio.

Some of us have visited your operation out there, Dr. Caponio, and again I think we have a high regard for it. You seem to have been spared the ax at least somewhat better than the rest of the operations there. Are there any major policy issues that will surface as a result either of the budget levels that you're under or what looks to me like fairly noncontroversial legislative changes you're recommending? I don't perceive any offhand.

Dr. CAPONIO. Mr. Chairman, I don't perceive any issues emerging as a result of our proposed amendments.

Mr. BROWN. Can you give me just a brief sketch as to what the curve is in terms of utilization of your services out there? Maybe that's included in your statement. Just go over it very briefly, your continuing to provide additional services to the business community and others who are interested.

Dr. CAPONIO. Yes, Mr. Chairman. As you probably more than any other Member of the Congress, realize and know so much about the NTIS operation, we are continuing to make available to U.S. business and industry virtually all of the results from federally-sponsored R&D.

We do this by way of making available all the necessary technical report literature, the machine-readable processed data files that the Federal Government and the Federal laboratories are generating, as well as providing a very active patent licensing program. We do not anticipate any difficulties in the coming years with respect to maintaining a full operation of these activities and services.

Mr. BROWN. All right. I won't comment on the fact that you generate quite a cash-flow, too, as a result of this operation. If you could keep all that money, you wouldn't have to ask for a budget, would you?

Dr. CAPONIO. Yes; that's correct, Mr. Chairman.

Mr. BROWN. All right. I have no further questions. I appreciate very much your being here.

Mr. Henry.

Mr. HENRY. Thank you, Mr. Chairman. With your leave, just one.

One question I note was a concern of both our staffs and is a public issue as well. As you seek to disseminate technical information and the fruits of Government research to our business community, there has been increasing concern that this is being exported abroad. In what ways are you monitoring, for example, Soviet or even Western or Japanese subscriptions and pamphlet requests? How are you addressing the concern that the secretary made mention of several weeks ago?

Dr. CAPONIO. First of all, Mr. Henry, as you probably know, the NTIS is the repository in the United States for making available the results of federally-sponsored R&D. Once a public document is in the public domain, it is very difficult to prevent its disclosure. The National Technical Information Service, under the guidance and the counsel of Dr. Merrifield, has placed an embargo on the distribution and sale of material to the U.S.S.R. and other U.S.S.R. satellite countries.

In this whole area of dissemination or technology transfer, it is sometimes very difficult to know how to restrict or control the distribution of certain types of unclassified sensitive information. I believe that you are alluding to the Secretary's comments. I think he is really making an appeal to those agencies—the Department of Defense, Department of Energy, and NASA, who are the major contributors to NTIS—to be sure they exercise a complete review before declassifying information that may be very sensitive.

Dr. Merrifield, who has provided the guidance and the counsel on this particular issue, I think, with your permission, would probably want to amplify on my statement.

Dr. MERRIFIELD. Well, it is a good question. The problem is that there are channels of communication through other countries that are very difficult to shut down, and so any information basically that gets into the NTIS data base ultimately can be accessed by the Russians or their friends. Whenever we find them, we shut them down. Recently, one in Switzerland was just shut down and so forth.

Again the problem comes back to adequately classifying the data in the beginning so that it doesn't get into the data base.

The alternative would be to restrict the use of that data base, which is very important for us and we would shoot ourselves in the foot if we overly restricted that.

Mr. HENRY. Thank you.

Mr. BROWN. Mr. Cobey.

Mr. COBEY. Dr. Caponio, we have a question here that we would like you to address. In the fiscal year 1985 authorization bill that was approved by the House of Representatives, there was $500,000 authorized for Japanese literature to be translated in an effort through NTIS. And during the appropriations process this money never reached NTIS. And our question is, was any money requested by NTIS for such an effort in the fiscal year 1986 budget; and if not, why not? Could you enlighten us on that, please?

Dr. CAPONIO. As you know, Mr. Cobey, the National Technical Information Service has an active program with respect to acquiring foreign technical information and especially the Japanese technical information. And within the past year we have negotiated arrangements and agreements with the Japanese Government to reciprocate in the exchange of technical information.

In view of the budget deficits, we feel we concur with the Department that the National Technical Information Service, because it is a self-supporting and self-sustaining agency, may be able to expand the program as a result of developing new information products that would pertain to the Japanese technology.

I might add that one of the basic questions in this whole area of acquiring and utilizing Japanese technology is the inability of most U.S. scientists and engineers to read the Japanese language; and so, therefore, the formidable barrier is the translation problem. Anyone who is familiar with the translation process knows that this is a very costly operation, so costly that even the private sector today is unable to handle it adequately.

But in response to your question, I think that NTIS is carrying out the program to the extent that we feel is adequate—and no program in this particular area is ever fully adequate—but we feel that we are covering the basic needs with respect to acquiring Japanese technical report literature.

Mr. COBEY. Let me see if I understand you. So you do have some translating going on?

Dr. CAPONIO. Yes; Mr. Cobey, we do. In terms of the translation, as a result of our agreements with the Japanese, they make available to us many of the technical reports with an English abstract. As you probably know, 20 percent of the material generated in Japan is already in English, the other 75 to 80 percent needs to be abstracted and translated. And we are developing programs whereby we will make the English abstract available, and then if there is a demand for the full report, we will try to get interagency support for the full translation.

Mr. COBEY. Thank you.

Mr. BROWN. Mr. Bruce, do you have any questions?

Mr. BRUCE. No, thank you, Mr. Chairman.

Mr. BROWN. On that same point, Dr. Caponio, my understanding is that there used to be a standing order for all of your output from the Soviets and a few other countries. Is that correct?

Dr. CAPONIO. Yes, Mr. Chairman, that is correct. There used to be, the U.S.S.R.

Mr. BROWN. When did this embargo go into effect on the U.S.S.R.?

Dr. CAPONIO. In 1980 the embargo on the distribution and the sales of all information products emanating from the Federal Government was placed.

Mr. BROWN. To the U.S.S.R.?

Dr. CAPONIO. And certain U.S.S.R. Soviet-bloc countries. We will submit for the record the entire list of countries.

Mr. BROWN. Will you do that?

Dr. CAPONIO. Yes, Mr. Chairman.

[The information follows:]

Listed below is a summary of sales restrictions on overseas sales currently in effect at NTIS.

U.S.S.R.: No sales of any NTIS products or services.
Poland: No sales of any NTIS products or services.
Czechoslovakia: No sales of any NTIS products or services.
Hungry: No sales of NTIS' Selected Research in Microfiche.

In addition, the following countries are restricted from sales of magnetic tape and other machine readable products.

Albania; Bulgaria; Hungary; German Democratic Republic (East Germany); Romania; and Yugoslavia.

Mr. BROWN. Since those same documents are available to any U.S. citizen who wants to order them and they're in the public domain, isn't this a fairly futile gesture?

Dr. CAPONIO. At best, Mr. Chairman, this is a delaying action. Once a document, as has been pointed out, is in the public domain, it is very difficult to prevent that document from being accessed by the U.S.S.R. or any other country.

Mr. BROWN. Was this an aftermath of the invasion of Afghanistan?

Dr. CAPONIO. Yes, Mr. Chairman. The embargo was placed in effect shortly after the Afghanistan situation.

Mr. BROWN. By the Carter administration.

Dr. CAPONIO. I believe so, Mr. Chairman.

Mr. **Brown**. You haven't brought up the subject to this administration how we could save a little money by lifting that embargo as we did in wheat?

Dr. **Caponio**. No, Mr. Chairman, I have not raised the issue of lifting the embargo.

Mr. **Brown**. All right.

Mr. Bruce, do you have any questions?

Mr. **Bruce**. No questions, Mr. Chairman.

Mr. **Brown**. All right. Thank you very much. I think we have no further questions. That's all.

Our next panel is the one that was originally scheduled.

Dr. Ambler, do you want to bring your whole crew up.

We have a very impressive and talented group with you here this morning, Dr. Ambler. Do you want to choreograph the proceedings in the appropriate way here?

STATEMENT OF DR. ERNEST AMBLER, DIRECTOR, NATIONAL BUREAU OF STANDARDS, ACCOMPANIED BY RAYMOND G. KAMMER, DEPUTY DIRECTOR; DR. JOHN W. LYONS, DIRECTOR, NATIONAL ENGINEERING LABORATORY; JAMES H. BURROWS, DIRECTOR, INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY; DR. DONALD R. JOHNSON, DIRECTOR, NATIONAL MEASUREMENT LABORATORY; AND DR. LYLE H. SCHWARTZ, DIRECTOR, CENTER FOR MATERIALS SCIENCE

Dr. **Ambler**. I would be very glad to, sir. On my immediate right is my deputy director, Mr. Kammer; the head of the National Engineering Laboratory, whom you know, Dr. Lyons; the head of the Institute for Computer Sciences and Technology, Mr. Burrows; the head of the National Measurement Laboratory, Dr. Johnson; and a recent recruit to the National Bureau of Standards, head of the Center for Materials Science, Dr. Lyle Schwartz, who joined us from Northwestern University a few months ago.

Mr. **Brown**. And Mr. Burrows is the one who looks sad this morning, is that right?

Dr. **Ambler**. He seems to be smiling at the moment, but maybe that was just because of the remark you made, sir.

Mr. **Brown**. Fine. You may proceed, Dr. Ambler.

Dr. **Ambler**. Thank you very much, Mr. Chairman. I am very pleased to appear before you again to request authorization of appropriations for the programs and activities of the National Bureau of Standards for fiscal year 1986.

I would like to summarize our authorization request of $120 million for fiscal year 1986 and then, with your permission, Mr. Chairman, each of the managers that I just introduced will review the activities and accomplishments and plans of the units for which they are responsible, in a brief form.

Mr. **Brown**. Dr. Ambler, we appreciate your restraint in summarizing the various reports, because of the time. The full text will be in the record, of course, and we would like a little time for questioning after you have finished.

Dr. **Ambler**. Yes, sir. I would like to take most of what time I have by dealing with the first part of my testimony, so I will be a little lengthy.

Mr. Brown. I didn't intend to restrict you, Dr. Ambler. You have very good judgment.

Dr. Ambler. The National Bureau of Standards, in my view, Mr. Chairman, has been very fortunate in having had since its foundation a clear legislative mission. Our organic act has given to our institution and to us as managers sitting at this table a direction and has provided a sound basis for discussion of our programs, especially with this subcommittee.

To be sure, the particular emphasis given to different aspects of our work changes as national priorities change. These changes in priorities have been brought out each year at these authorization hearings as well as at other hearings before the Congress. But at no time in the past can I remember the mission of NBS being so much in tune with the times, whether we related our work to the Department of Commerce, to national science policy as stated by the President's science advisor, or the general sentiment, as we perceive it, in both Houses of Congress.

Indeed, if I may say so, the points made at the outset by Mr. Ritter concerning the—well, he didn't use the phrase "in tune with the times," I used that phrase—but as a national laboratory I think I understood those were the gist of his remarks. And I thoroughly agree with them.

And the reason for that is not very hard to see. Assuring the continuing growth and strengthening of our economy, especially in the application of science and technology to our industries, is a theme that most, if not all, sectors of our society seem to support enthusiastically.

To be sure, there is some difference of opinion about the appropriate role of the Federal Government relative to the responsibility of the others, but there are more agreements than differences, and such differences as may remain seem to me to be fading rapidly.

For example, the call for cooperation among various sectors carrying out research and development—universities, industry, and government—is universal and is being responded to by each of the sectors, not by following some central and rigid prescription—again I think, as was pointed out by Mr. Ritter—but by groups in different parts of the country getting together voluntarily to cooperate to their mutual advantage.

And I find our own experience both heartening and impressive. Our interactions with industrial measurement users have always been strong, and they're growing stronger. For example, over the past 4 years we have increased participation in our Industrial Research Associate Program by more than 60 percent. We now have in excess of 150 researchers from private companies and other institutions working at NBS on areas of mutual interest, with their sponsors—not NBS—paying their salaries.

Our Guest Worker Program is up by more than 40 percent, 523 researchers working at NBS. The dollar value for measurement calibration services we provide is up 70 percent, and the dollar volume of sales of our standard reference materials is up 47 percent since 1980.

Most dramatically, the estimated value of cost sharing and assistance in kind by those who are interested in and need NBS research and services has increased by 265 percent over the past 4 years. That's a concrete measure of the value of NBS's work.

Another important indicator is the report of the White House Science Council Federal Laboratory Review Panel, known in brief as the Packard Committee. There is a very high level of interest in focusing our national R&D effort, and this report is just one expression of that interest.

In this climate, as the Director of the National Bureau of Standards, I feel excitement, I feel enthusiasm, and I feel pride. Our mission is vital. It is more important than ever before, not only in our own view but in relation to the policies of this administration and also of Congress and in the tangible expressions of support from our users.

The NBS role of providing reliable, accurate scientific and engineering measurements and data is one that I don't have to belabor before this committee. Most of you have taken part in previous authorization hearings for NBS. Many of you have visited NBS, and some of you saw the exhibit we displayed in this room a few weeks ago.

If I might just say, Mr. Chairman, I would like to thank this committee sincerely for the opportunity to place those exhibits in this room on January 31. They were a big success; so much so, if I may say so, that the Senate has asked for the same thing. And they will be displayed this afternoon in the rotunda of the Russell Building, and they will be there until half past 4. So any of the members who didn't get to see the exhibit on the 31st of January may wish to go over to the Russell Building this afternoon and catch it there.

I won't go into the details of our program. My colleagues will discuss some aspects of that. But I would like to present to you one set of facts that I do find persuasive, and they identify with the economic importance of NBS measurement services.

You know, one of the most often-asked questions I get is, "Tell me, Dr. Ambler, just exactly what is the National Bureau of Standards—what does it do?" We provide a range of measurement services and data that are essential to the economy. They're very broad. They're very broad technically. They serve a very broad range of clientele. And everybody uses them; everybody makes measurements, from the person in the street to the most advanced researcher in the high-technology business, everywhere, no matter what you're doing—flying airplanes or whatever.

And support for that is a very important, yet underlying, thing that often doesn't pop out like a big national program like putting somebody on the Moon would, but it's extremely important. And we decided that we'd try to figure out just in economic terms how important that is.

What we found was that across the Nation as a whole, $163 billion was spent on measurements in 1983, when we had the figures, which is 3.5 percent of the GNP. Nearly one-half of that total is concentrated in 20 sectors, including such fields as electronic components, where 20 percent of that industry's labor costs are for measurement.

Industry requires a sound system on which to base measurements which are vital to the research upon which new products are developed, and it's important to the assurance of quality and efficiency in manufacturing and to the maintenance of equity in trade.

Working with industry, NBS plays the central role in developing the basis to which all these measurements are referred, and we derive a great amount of satisfaction from the role we play in this cooperative enterprise with the private sector, which in its comprehensiveness, fills society's needs and assures the accuracy and objectivity necessary for public confidence.

So even as we deal with very difficult budget decisions, and quite apart from the specific proposals, I hope that I have been able to convey to you, as I have always felt, the very positive and upbeat way I feel about the National Bureau of Standards as a national laboratory, particularly at this time.

The budget that we're presenting to you at this time contains four major program initiatives. I will just mention them briefly, and the others we will go into a little more detail.

I would first like to mention the cold neutron research facility is a request for $8 million. Congress has already appropriated funds for the cold neutron source for the reactor, which we're proceeding with, but this is for an experimental hall. It's first a request that we will be coming with for the next 4 years, to build a national facility with 15 experimental stations that will be available as a fully national user facility for industries and universities and others.

We have a request for $1.9 million for process and quality control measurements. We came forward with a request last year, Mr. Chairman, in this same category, and there was appropriated $500 million, but this is an area that serves the very core——

Mr. **Brown**. How many hundred millions did you say?

Dr. **Ambler**. $500,000, sir. Did I say $500 million? $500,000. And we're requesting $1.9 million this year for it.

Mr. **Brown**. I just wanted to show you I was listening, Dr. Ambler. [Laughter.]

Dr. **Ambler**. The other area that we're requesting appropriations for is in the area of biotechnology. That is a $3 million request. Again, one of the members mentioned this economic war that we're in. In fact, there was a very important report published by the National Academy of Science's Research Panel on Biotechnology, chaired by Dr. Art Humphrey. And the quote from him says, "We are at war. An economic war is being waged on the battlefields of high-technology commercialization, and biotechnology is one of those areas."

We expect to provide various measurement services and data in that area.

Then we have a request in advanced ceramics, for $3.5 million, to provide the kind of material support we traditionally provide to this expanding field.

There is one other increase in our fiscal year 1986 proposal of $4.9 million, which includes adjustment for various things such as cost of pay increases and so on and so forth that are detailed in the budget.

There are program decreases in the budget presented to you. The Center for Building Technology will be eliminated, for a reduction of $3.1 million. In the last 10 years the Federal Government has spent $40 million on this program, and it is now appropriate for this effort to be assumed by the private sector and State and local governments.

The Federal Automated Data Processing Standards Program in Mr. Burrows' institute is proposed to be funded at $5 million. And the Center for Fire Research would be eliminated, for a further reduction of $5.1 million. Again, the Federal Government has invested $50 million in this area in the last 10 years.

Our Equipment Replacement Program, which was established in 1976 to provide NBS with an equipment level comparable to research laboratories in the country—and which has been very successful, Mr. Chairman—will reach its goal in fiscal year 1985, permitting the fiscal year 1986 budget to be reduced by $3.3 million with minimal program impact.

Other decreases represent absorptions and reductions for fiscal year 1986, detailed in the budget on page 17—and there are various titles, four titles to that—the total is a reduction of $8.8 million.

So, in summary, Mr. Chairman, I believe that you have before you a budget that is the result of the administration's careful evaluation of NBS programs and priorities. It's a budget which reflects an appropriate level of resources necessary for NBS to serve industry, Government, and academia at a time when this country is increasingly dependent on science and technology advancement.

NBS is the only Federal agency that supplies the measurement research and services that serve as the vital connection to link the tens of billions of dollars of research and development that this Nation spends every year with the end result of innovation and productivity improvement for the U.S. economy.

I do believe we've done the very best job that we could with the resources that have been available to us, and we believe that this budget will permit us to meet the needs of industry in critical areas. And I would urge the committee to support us in this.

Thank you, Mr. Chairman. I would be pleased to answer questions, although you may wish to hear from the others first.

[The prepared statement of Dr. Ambler follows:]

U.S. DEPARTMENT OF COMMERCE
STATEMENT OF ERNEST AMBLER, DIRECTOR
NATIONAL BUREAU OF STANDARDS
BEFORE THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
ON AUTHORIZATION OF APPROPRIATIONS FOR THE ACTIVITIES OF
THE NATIONAL BUREAU OF STANDARDS

FEBRUARY 26, 1985

I AM PLEASED TO APPEAR BEFORE YOU TODAY TO REQUEST AUTHORIZATION OF APPROPRIATIONS FOR THE PROGRAMS AND ACTIVITIES OF THE NATIONAL BUREAU OF STANDARDS (NBS) IN FISCAL YEAR 1986.

ACCOMPANYING ME IS THE DEPUTY DIRECTOR OF NBS, MR. RAYMOND G. KAMMER; THE DIRECTOR OF THE NATIONAL MEASUREMENT LABORATORY, DR. DONALD R. JOHNSON; THE DIRECTOR OF THE NATIONAL ENGINEERING LABORATORY, DR. JOHN W. LYONS; THE DIRECTOR OF THE INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY, MR. JAMES H. BURROWS; AND THE DIRECTOR OF THE CENTER FOR MATERIALS SCIENCE, DR. LYLE H. SCHWARTZ.

I WILL SUMMARIZE OUR AUTHORIZATION REQUEST OF $120 MILLION FOR FISCAL YEAR 1986, AND EACH OF THESE MANAGERS WILL REVIEW THE ACTIVITIES, ACCOMPLISHMENTS, AND PLANS FOR THE NBS UNITS FOR WHICH THEY ARE RESPONSIBLE.

The National Bureau of Standards has been fortunate in my view, in having had, since its foundation, a clear legislated mission. Our Organic Act has given to our institution and to us as managers a direction and has provided a sound basis for discussion of our programs especially with this subcommittee.

To be sure, the particular emphasis given to different aspects of our work changes as national priorities change. These changes in priorities have been brought out each year at these Authorization Hearings as well as at other hearings before Congress. But at no time in the past can I remember the mission of NBS being so much in tune with the times, whether we relate our work to the objectives of the Department of Commerce, to national science policy as stated by the President's Science Advisor, or to the general sentiment, as we perceive it, in both Houses of Congress.

I REFER PARTICULARLY TO ASSURING THE CONTINUING GROWTH AND STRENGTHENING OF OUR ECONOMY, ESPECIALLY THROUGH THE APPLICATION OF SCIENCE AND TECHNOLOGY TO OUR INDUSTRIES. THIS IS A THEME THAT MOST, IF NOT ALL, SECTORS OF OUR SOCIETY SEEM TO SUPPORT ENTHUSIASTICALLY. TO BE SURE, THERE ARE SOME DIFFERENCES OF OPINION ABOUT THE APPROPRIATE ROLE FOR THE FEDERAL GOVERNMENT RELATIVE TO THE RESPONSIBILITIES OF OTHERS, BUT THERE ARE MORE AGREEMENTS THAN DIFFERENCES AND SUCH DIFFERENCES AS MAY REMAIN SEEM TO ME TO BE FADING RAPIDLY. FOR EXAMPLE, THE CALL FOR COOPERATION AMONG THE VARIOUS SECTORS CARRYING OUT RESEARCH AND DEVELOPMENT--UNIVERSITIES, INDUSTRY, AND GOVERNMENT--IS UNIVERSAL AND IS BEING RESPONDED TO BY EACH OF THESE SECTORS; NOT BY FOLLOWING SOME CENTRAL AND RIGID PRESCRIPTION, BUT BY GROUPS IN DIFFERENT PARTS OF THE COUNTRY GETTING TOGETHER VOLUNTARILY TO COOPERATE TO THEIR MUTUAL ADVANTAGE. I FIND OUR OWN EXPERIENCE BOTH HEARTENING AND IMPRESSIVE.

OUR INTERACTIONS WITH INDUSTRIAL MEASUREMENT USERS HAVE ALWAYS BEEN STRONG, AND THEY ARE GROWING STRONGER. FOR EXAMPLE, OVER THE PAST FOUR YEARS, WE HAVE INCREASED PARTICIPATION IN OUR INDUSTRIAL RESEARCH ASSOCIATE PROGRAM BY MORE THAN 60 PERCENT. WE NOW HAVE IN EXCESS OF 150 RESEARCHERS FROM PRIVATE COMPANIES AND OTHER INSTITUTIONS WORKING AT NBS ON AREAS OF MUTUAL INTEREST--WITH THEIR SPONSORS, NOT NBS, PAYING THEIR SALARIES. OUR GUEST WORKER PROGRAM IS UP BY MORE THAN 40 PERCENT, TO 523 RESEARCHERS WORKING AT NBS. THE DOLLAR VALUE FROM MEASUREMENT CALIBRATION SERVICES WE PROVIDE IS UP 70 PERCENT, AND THE DOLLAR VOLUME FOR SALES OF OUR STANDARD REFERENCE MATERIALS IS UP 47 PERCENT FROM 1980.

MOST DRAMATICALLY, THE ESTIMATED VALUE OF COST-SHARING AND ASSISTANCE-IN-KIND BY THOSE WHO ARE INTERESTED IN AND NEED NBS RESEARCH AND SERVICES HAS INCREASED BY 265 PERCENT OVER THE PAST FOUR YEARS. THAT IS A CONCRETE MEASURE OF THE VALUE OF NBS' WORK.

ANOTHER IMPORTANT INDICATOR IS THE REPORT OF THE WHITE HOUSE SCIENCE COUNCIL FEDERAL LABORATORY REVIEW PANEL (PACKARD REPORT). THERE IS A VERY HIGH LEVEL OF INTEREST IN FOCUSING OUR NATIONAL R&D EFFORT, AND THIS REPORT IS JUST ONE EXPRESSION OF THAT INTEREST.

IN THIS CLIMATE, AS DIRECTOR OF THE NATIONAL BUREAU OF STANDARDS, I FEEL EXCITMENT, ENTHUSIASM, AND PRIDE. OUR MISSION IS VITAL AND MORE IMPORTANT THAN EVER BEFORE, NOT ONLY IN OUR OWN VIEW BUT IN FOLLOWING THE POLICIES OF THIS ADMINISTRATION AND ALSO OF CONGRESS AND IN THE TANGIBLE EXPRESSIONS OF SUPPORT FROM OUR USERS.

THE NBS ROLE OF PROVIDING ACCURATE, RELIABLE, SCIENTIFIC, AND ENGINEERING MEASUREMENTS AND DATA IS ONE I DO NOT NEED TO BELABOR BEFORE THIS COMMITTEE. MOST OF YOU HAVE TAKEN PART IN PREVIOUS AUTHORIZATION HEARINGS FOR NBS, MANY OF YOU HAVE VISITED NBS, AND SOME OF YOU SAW THE EXHIBIT WE DISPLAYED IN THIS ROOM A FEW WEEKS AGO. IT IS DIFFICULT TO EXPLAIN IN A FEW WORDS THE RANGE OF DISCIPLINES WE MUST COVER IN THE PHYSICAL SCIENCES AND ENGINEERING AND EQUALLY DIFFICULT TO ENUMERATE THE RANGE OF USERS OF OUR SERVICES. MY COLLEAGUES WILL GIVE YOU SOME EXAMPLES.

PERMIT ME TO GIVE YOU JUST ONE SET OF FACTS THAT I FIND PERSUASIVE; THOSE WHICH IDENTIFY THE ECONOMIC IMPORTANCE OF NBS MEASUREMENT SERVICES.

MEASUREMENTS ARE IMPORTANT IN MOST SEGMENTS OF THE U.S. ECONOMY, BUT PARTICULARLY SO IN THOSE INDUSTRIES WHERE THE APPLICATION OF SCIENCE AND ENGINEERING ARE PRODUCING VERY HIGH GROWTH RATES. ACROSS THE WHOLE OF THE NATION'S ECONOMY $163 BILLION WAS SPENT ON MEASUREMENTS IN 1983, WHICH IS 3.5 PERCENT OF THE GNP. NEARLY HALF OF THAT TOTAL IS CONCENTRATED IN 20 SECTORS INCLUDING SUCH FIELDS AS ELECTRONIC COMPONENTS WHERE 20 PERCENT OF THAT INDUSTRY'S LABOR COSTS ARE FOR MEASUREMENTS. INDUSTRY REQUIRES A SOUND SYSTEM UPON WHICH TO BASE MEASUREMENTS WHICH ARE VITAL TO THE RESEARCH UPON WHICH NEW PRODUCTS ARE DEVELOPED, TO THE ASSURANCE OF QUALITY AND EFFICIENCY IN MANUFACTURING OPERATIONS, AND TO THE MAINTENANCE OF EQUITY IN TRADE. WORKING WITH INDUSTRY, NBS PLAYS THE CENTRAL ROLE IN DEVELOPING THE BASIS TO WHICH ALL THESE MEASUREMENTS ARE REFERRED.

WE DERIVE A GREAT AMOUNT OF SATISFACTION FROM THE ROLE WE PLAY IN THIS COOPERATIVE ENTERPRISE WITH THE PRIVATE SECTOR WHICH IN ITS COMPREHENSIVENESS FILLS SOCIETY'S NEEDS AND ASSURES THE ACCURACY AND OBJECTIVITY NECESSARY FOR PUBLIC CONFIDENCE.

SO EVEN AS WE DEAL WITH VERY DIFFICULT BUDGET DECISIONS AND QUITE APART FROM THOSE SPECIFIC PROPOSALS, I HOPE I HAVE BEEN ABLE TO CONVEY TO YOU WHY I FEEL SO POSITIVE AND UPBEAT ABOUT NBS AS A NATIONAL LABORATORY, PARTICULARLY AT THIS TIME.

THE BUDGET THAT WE ARE PRESENTING TO YOU TODAY CONTAINS FOUR MAJOR PROGRAM INITIATIVES. I WILL REVIEW THEM FOR YOU BRIEFLY, AND MY COLLEAGUES WILL GIVE YOU ADDITIONAL DETAILS.

THE FISCAL YEAR 1986 BUDGET PROPOSAL CONTAINS A REQUEST OF $8 MILLION TO ESTABLISH A COLD NEUTRON RESEARCH FACILITY ADJACENT TO THE NBS REACTOR BY CONSTRUCTING AN EXPERIMENTAL HALL EQUIPPED WITH BEAM HANDLING TUBES THAT WILL SERVICE 15 EXPERIMENTAL STATIONS. THIS NATIONAL RESEARCH FACILITY WILL BE A UNIQUE CAPABILITY CRITICAL TO THE ADVANCEMENT OF MATERIALS SCIENCE IN THE UNITED STATES. THE COUNTRY FACES SEVERE MATERIALS CHALLENGES IN DEVELOPING ADVANCED MATERIALS SUCH AS CERAMICS, COMPOSITES AND POLYMERS, FOR USE IN COMMUNICATIONS, ELECTRONICS, AEROSPACE, MEDICINE, BIOMOLECULAR ENGINEERING, AND OTHER FIELDS. IN ALL OF THESE AREAS, COLD NEUTRON BEAMS WILL BE AN INVALUABLE RESEARCH TOOL. THIS FACT HAS BEEN RECOGNIZED BY A HIGH LEVEL COMMITTEE OF THE NATIONAL ACADEMY OF SCIENCES AS THE SINGLE MOST IMPORTANT RESOURCE FOR SOLVING THESE PROBLEMS NOW AND IN THE NEAR-TERM FUTURE. COLD NEUTRON EXPERIMENTAL FACILITIES, WHICH WERE SPECIFICALLY ENDORSED BY THEM AND GIVEN HIGHEST PRIORITY FOR ADDITIONS TO EXISTING FACILITIES, WILL PROVIDE INTENSE BEAMS OF LONG WAVELENGTH NEUTRONS THAT ARE ABLE TO MAKE KEY MEASUREMENTS OF THE INTERNAL STRUCTURE OF A WIDE RANGE OF MATERIALS.

THE UNITED STATES DOES NOT HAVE A FACILITY LIKE THE ONE IN GRENOBLE, FRANCE, WHERE MORE THAN $140 MILLION HAS BEEN INVESTED IN COLD NEUTRON FACILITIES. A FACILITY LIKE THE ONE PROPOSED AT NBS IS NOT FEASIBLE FOR THE PRIVATE SECTOR BECAUSE OF THE CAPITAL INVESTMENT REQUIRED FOR A RESEARCH REACTOR AND ENVIRONMENTAL CONSTRAINTS ON THE CONSTRUCTION. THE NBS REACTOR ALREADY HAS THE CAPABILITY TO PRODUCE THE COLD NEUTRONS AND IS THE ONLY RESEARCH REACTOR IN THIS COUNTRY WHICH WILL ALLOW THE INSTALLATION OF A COLD NEUTRON SOURCE LARGE ENOUGH TO HANDLE THE ARRAY OF INSTRUMENTS AND WORK STATIONS WHICH U.S. RESEARCHERS NEED.

FUNDING FOR THE DEVELOPMENT OF THE COLD NEUTRON SOURCE ITSELF WAS PROVIDED IN THE FISCAL YEAR 1985 BUDGET FOR NBS. THE INCREASE WE ARE REQUESTING, THE FIRST OF FOUR YEARS, WOULD PROVIDE FACILITIES NECESSARY TO FULLY EXPLOIT THIS SOURCE. THE FISCAL YEAR 1986 FUNDS WOULD PERMIT US TO COMPLETE FACILITY DESIGN AND BEGIN CONSTRUCTION OF THE EXPERIMENTAL HALL AND COLD NEUTRON GUIDES. THE PLANS FOR THIS WORLD CLASS FACILITY INCLUDE FOUR NEW BEAM PORTS TO SUPPORT 15 EXPERIMENTAL STATIONS. FOUR OF THE EXPERIMENTAL STATIONS ARE EXPRESSLY DESIGNATED FOR INDUSTRIAL USERS. SINCE OUR AIM IS TO OPERATE A TRULY NATIONAL FACILITY, CLEARLY THE EARLY OPERATION OF THE EXPERIMENTAL STATIONS AVAILABLE TO THE PRIVATE SECTOR ARE A VERY HIGH PRIORITY.

EARLIER, I MENTIONED THAT THE MISSION OF NBS IS VERY MUCH IN TUNE WITH THE TIMES. NOWHERE IS THIS CLEARER THAN IN OUR FUNCTION TO PROVIDE MEASUREMENT SERVICES IN THE PHYSICAL SCIENCES. IN ORDER TO REMAIN COMPETITIVE, INDUSTRY MUST INCREASE THE EFFICIENCY OF ITS MANUFACTURING OPERATIONS. THIS IS ESPECIALLY TRUE WITH THE MORE SOPHISTICATED AND HIGHER VALUE-ADDED PRODUCTS. ADVANCES IN TECHNOLOGY PLACE INCREASED DEMANDS ON NBS MEASUREMENT SERVICES, SINCE NEW MEASUREMENT SERVICES DO NOT ALWAYS SUPPLANT OUR MORE TRADITIONAL ONES. THUS, WE ARE FACED WITH PROVIDING ADDITIONAL MEASUREMENTS AND STANDARDS WHILE CONTINUING TO MAINTAIN MUCH OF OUR EXISTING ARRAY OF SERVICES. WE ARE REQUESTING $1.9 MILLION FOR PROCESS AND QUALITY CONTROL MEASUREMENTS WHICH WOULD INCREASE OUR LEVEL OF EFFORT IN THESE AREAS AND FUND THE DEVELOPMENT OF ADVANCED MEASUREMENT METHODS AND BASIC STANDARDS SORELY NEEDED BY INDUSTRY. THE NEW SERVICES WOULD BE IN AREAS SUCH AS SPECTRORADIOMETRY, IMPEDANCE, AND MICROWAVE MEASUREMENTS, ALL OF WHICH HAVE BEEN IDENTIFIED BY INDUSTRY AS TOP PRIORITIES.

CLEARLY AS MANUFACTURING TECHNOLOGY BECOMES MORE COMPLEX, AS AUTOMATION INCREASES, AND AS QUALITY CONTROL BECOMES AN INTEGRAL PART OF THE MANUFACTURING PROCESS ITSELF, THE ROLE PLAYED BY MEASUREMENT BECOMES MORE CRUCIAL. THE PROCESS AND QUALITY CONTROL INITIATIVE WILL ALLOW INDUSTRY TO MOVE FORWARD AND MEET THE COMPETITION.

Please allow me to quote you a few words of Dr. Arthur Humphrey, Chairman of the National Academy of Sciences Research Panel on Biotechnology. "We are at war! An economic war . . . is being waged on the battlefields of high-technology commercialization."

He and his Committee have prepared a detailed and much publicized report identifying the prime areas of research for and principle technical barriers to the commercialization of biotechnology. The stakes are high! Estimates of the world market for biotechnology-related products by the year 2000 range from $40 to $70 billion/year. The Humphrey Report, published by the National Academy of Sciences at the end of 1984, has three major conclusions: the chief obstacles to commercialization are likely to be engineering in nature; U.S. should substantially increase research leading to new reactor concepts; and, we must develop a new class of unit operations for handling macromolecules. The $3 million NBS request for Industrial Applications of Biotechnology is completely consistent with those three conclusions. Our planned efforts in new measurement techniques for compositional determination and the development of data and models for enzyme-catalyzed reactions are pivotal elements to the creation of new reactor concepts.

WE ALSO PLAN WORK ON BIOLOGICALLY-COMPATIBLE SENSORS AND SEPARATION MEASUREMENTS WHICH ARE ESSENTIAL TO THE DEVELOPMENT OF THE NEW CLASS OF CHEMICAL ENGINEERING UNIT OPERATIONS NEEDED TO HANDLE MACROMOLECULAR STRUCTURES. GENERIC RESEARCH OF THE TYPE NBS WOULD SUPPORT IS NEEDED BY VIRTUALLY ALL COMPANIES, YET IS TOO EXPENSIVE TO BE UNDERTAKEN BY INDIVIDUAL FIRMS, PARTICULARLY THE MANY SMALL FIRMS WHICH COMPRISE THIS INDUSTRY. OUR RESEARCH WILL BE CONDUCTED IN COLLABORATION WITH OTHER GOVERNMENT AGENCIES, INDUSTRY, AND UNIVERSITIES IN ORDER TO TAKE ADVANTAGE OF THE BIOLOGICAL EXPERTISE OF THOSE ORGANIZATIONS AND TO ENSURE TIMELY AND EFFECTIVE TRANSFER OF NBS-DEVELOPED RESULTS TO THOSE ORGANIZATIONS NEEDING THEM.

CERAMICS OFFER ENORMOUS POTENTIAL AS REPLACEMENTS FOR A WIDE VARIETY OF EXISTING, MORE COSTLY MATERIALS. THESE ADVANCED CERAMICS REPRESENT A NEW GENERATION OF MATERIALS PARTICULARLY SUITED FOR CERTAIN HIGH TECHNOLOGY AND RELATED APPLICATIONS. THESE CERAMICS POSSESS UNIQUE PROPERTIES, ESPECIALLY RESISTANCE TO CORROSION, HIGH TEMPERATURES, AND WEAR WHICH OPEN UP A VAST ARRAY OF NEW APPLICATIONS SUCH AS IN ADVANCED HEAT ENGINES, CUTTING TOOLS, SENSORS, BIOMEDICAL DEVICES, AND ELECTRONIC AND OPTICAL COMPONENTS. THE PRINCIPLE BARRIER TO COMMERCIALIZATION OF THESE MATERIALS IS THE INABILITY TO CONTROL PRODUCTION PROCESSES SO THAT CERAMIC PRODUCTS POSSESS UNIFORM AND PREDICTABLE PERFORMANCE CHARACTERISTICS. WE ARE REQUESTING $3.5 MILLION TO ADDRESS THE MEASUREMENT PROBLEMS WHICH MAKE UP A LARGE PART OF THAT BARRIER. AS WITH MANY MEASUREMENT PROBLEMS, THESE ARE GENERIC IN NATURE AND NOT SPECIFIC TO A GIVEN APPLICATION OR SEGMENT OF THE INDUSTRY.

THE NBS EFFORT WILL FOCUS ON THE MEASUREMENT SERVICES REQUIRED TO CONTROL THE MICROCRACKS WHICH FORM IN CERAMICS AND WHICH ARE THE CAUSE OF UNRELIABLE PERFORMANCE. U.S. INDUSTRY IS FACING STIFF COMPETITION IN THIS AREA, WITH JAPAN ALREADY DOMINATING CERAMICS FOR ELECTRONIC COMPONENTS, CONTROLLING 50% OF THE $4.1 BILLION WORLD MARKET. AT STAKE FOR THE COUNTRY ARE NOT JUST THE INDUSTRIES WHICH PRODUCE THE ADVANCED CERAMICS, BUT ALSO THE MYRIAD OF INDUSTRIES WHICH WILL USE CERAMICS IN MANUFACTURING THEIR OWN PRODUCTS. RAPID GROWTH IS EXPECTED IN CERAMICS WITH SALES REACHING $19 BILLION/YEAR A DECADE FROM NOW. IT IS CLEAR THAT ONE OF THE KEYS TO INDUSTRIAL SUCCESS IN THE FUTURE IS THE ABILITY TO BE VERSATILE AND INNOVATIVE IN MATERIALS SCIENCE AND ENGINEERING. ADVANCED CERAMICS IS A GOOD EXAMPLE OF A FIELD IN WHICH OUR NATION'S INDUSTRY MUST MOVE AHEAD, AND THIS NBS PROGRAM WILL GO A LONG WAY TOWARD ESTABLISHING THE MEASUREMENT BASE REQUIRED FOR THAT MOVEMENT.

THERE IS ONE OTHER INCREASE IN OUR FISCAL YEAR 1986 PROPOSAL OF $4.9 MILLION, WHICH INCLUDES ADJUSTMENTS FOR NEXT YEAR'S COSTS OF THE FISCAL YEAR 1985 PAY INCREASE, AND OTHER INCREASES AND DECREASES FOR PERSONNEL AND VITAL SERVICES.

There are program decreases in the budget presented to you. The NBS Center for Building Technology would be eliminated (-$3.1 million). In the last 10 years, the Federal government has spent $40 million on this program. It is now appropriate for this effort to be assumed by the private sector and state and local governments. The Federal automated data processing, or ADP, standards program in our Institute for Computer Sciences and Technology (ICST) is proposed to be funded at $5 million. ICST will concentrate on international networking of computers while voluntary standards organizations would be relied upon for the majority of computer-related Federal standards. The NBS Center for Fire Research would be eliminated (-$5.1 million). Again, the Federal government has invested $50 million in this area in the last 10 years. This research should now be taken over by the private sector and state and local governments.

Our equipment replacement program, which was established in 1976 to provide NBS with an equipment level equivalent to comparable research laboratories, will reach its goal in fiscal year 1985, permitting the fiscal year 1986 budget to be reduced by $3.3 million with minimal program impact.

Other decreases represent absorptions and reductions for a fiscal year 1986 Federal pay cut of 5 percent ($2.4 million), administrative services reductions and productivity reviews ($3.0 million), reductions to carry out the Deficit Reduction Act of 1984 ($1.2 million), and absorptions of base adjustments ($2.2 million).

IN SUMMARY, I BELIEVE THAT YOU HAVE BEFORE YOU A BUDGET THAT IS THE RESULT OF THE ADMINISTRATION'S CAREFUL EVALUATION OF NBS PROGRAMS AND PRIORITIES. IT IS A BUDGET WHICH REFLECTS AN APPROPRIATE LEVEL OF RESOURCES NECESSARY FOR NBS TO SERVE INDUSTRY, GOVERNMENT, AND ACADEMIA AT A TIME WHEN THIS COUNTRY IS INCREASINGLY DEPENDENT ON SCIENCE AND TECHNOLOGY ADVANCEMENT. NBS IS THE ONLY FEDERAL AGENCY THAT SUPPLIES THE MEASUREMENT RESEARCH AND SERVICES THAT SERVE AS THE VITAL CONNECTION TO LINK THE TENS OF BILLIONS OF DOLLARS OF RESEARCH AND DEVELOPMENT THAT THIS NATION SPENDS EVERY YEAR WITH THE END RESULT OF INNOVATION AND PRODUCTIVITY IMPROVEMENT FOR THE U.S. ECONOMY.

WE AT NBS HAVE DONE THE BEST JOB POSSIBLE WITH THE RESOURCES THAT HAVE BEEN AVAILABLE TO US. THE COUNTRY NEEDS NEW MEASUREMENT INFORMATION AND SERVICES, AND WE AT NBS NEED TO MOVE AHEAD IN SOME NEW AND IMPORTANT PROGRAMS. WE BELIEVE THAT THIS BUDGET WILL PERMIT US TO MEET THE NEEDS OF INDUSTRY IN CRITICAL AREAS, AND I URGE THE COMMITTEE TO SUPPORT THIS BUDGET.

THANK YOU, MR. CHAIRMAN AND MEMBERS. I WILL BE PLESED TO ANSWER ANY QUESTIONS YOU MAY HAVE.

UNITED STATES DEPARTMENT OF COMMERCE
National Bureau of Standards
Gaithersburg, Maryland 20899
OFFICE OF THE DIRECTOR

FEBRUARY 1985

ERNEST AMBLER, DIRECTOR

Dr. Ernest Ambler became the eighth Director of the National Bureau of Standards in February 1978. At the request of Secretary of Commerce Malcolm Baldrige, he has continued as Director for the Reagan Administration. Dr. Ambler joined NBS in 1953 and has worked throughout his career to make NBS an increasingly valuable scientific and technical resource for industry, business, government, education, and the public.

As Director of NBS, Dr. Ambler leads the Nation's measurement laboratory in the physical sciences and engineering. NBS directly supports the commerce, industry, and science of the Nation by producing and delivering measurement products and services. These products and services provide the basis for the exchange of goods, the accurate specification of products, quality control methods for production, and scientific advances. NBS contributes directly to the competitiveness of U.S. industry by maintaining and improving the Nation's measurement capabilities. The Bureau's headquarters are located in Gaithersburg, Maryland, with a second laboratory in Boulder, Colorado.

As a scientist, he has contributed directly to the state-of-the-art in measurement technology. His expertise in nuclear physics and cryogenics formed the basis in 1956 for a cooperative effort that disproved the law of parity conservation, a concept that nuclear scientists had adhered to for more than 30 years. This pioneering project confirmed experimentally the theoretical work of Nobel Prize winners T. D. Lee and C. N. Yang.

As an administrator, Dr. Ambler has helped guide Bureau operations and policies to improve the efficiency with which NBS fulfills its mission. His management responsibilities began in 1961 when he became Chief of the Cryogenic Physics Section. Four years later he was appointed Chief of the Inorganic Materials Division. In 1968, as Director of the Institute for Basic Standards, he assumed responsibility for directing the most basic of NBS research activities: developing and maintaining standard and measurement techniques for such quantities as length, mass, time and frequency, and temperature. He was appointed Deputy Director of NBS in 1973, and Acting Director in 1975.

Among Dr. Ambler's continuing concerns is the Bureau's role in international science. He has long acknowledged that through its mission and diversity, the Bureau can act as a prime agent in international scientific cooperation and can support U.S. foreign commerce through participation in international standardization activities. In 1972 Dr. Ambler was elected to serve as the U.S. representative to the International Committee of Weights and Measures (CIPM), the executive body of the General Conference of Weights and Measures. He is chairman of that organization's Consultative Committee of Standards for Measuring Ionizing Radiation and Consultative Committee of Electricity. He became the Department of Commerce member on the Board of Governors of the Israel/U.S. Binational Industrial Research and Development Foundation in September 1981.

Dr. Ambler is a member of the American Association for the Advancement of Science, a fellow of the American Physical Society, and as Director of NBS, is ex officio President of the National Conference on Weights and Measures. He was commissioned by the Governor of Maryland in 1983 to serve on Maryland's High Technology Roundtable. He serves on the Commission on Higher Education for Maryland's Montgomery County Government.

Dr. Ambler is the recipient of numerous honors, awards, and fellowships including: The Department of Commerce Gold Medal, the NBS Stratton Award, Nuffield Fellow of Oxford University, the John Simon Guggenheim Memorial Foundation Fellowship Award, the John Price Wetherill Medal of the Franklin Institute, the Washington Academy of Sciences Award, the Arthur S. Flemming Award, the William A. Wildhack Award, and the President's Award for Distinquished Federal Civilian Service. He authored 52 publications and holds a patent for low temperature refrigeration apparatus and processes.

Born in Bradford, Yorkshire, England, in 1923, Dr. Ambler earned his B.A., M.A., and Ph.D. in physics at Oxford University before coming to the National Bureau of Standards. He became a United States citizen in 1958. Dr. Ambler and his wife, Alice Seiler Ambler, a former staff member in the NBS Heat and Building Research Divisions, were married in 1955. They live in Bethesda, Maryland, and have two sons, Christopher and Jonathan.

Mr. **Brown**. I was going to call on the other members of the panel, but if you would permit me, Dr. Ambler, I would like to call on our distinguished ranking minority member, Mr. Lujan, in case he might have to leave later. He might have a stirring statement like Mr. Ritter had that he would like to make at this time.

Mr. **Lujan**. Mr. Chairman, I don't have a stirring statement. As a matter of fact, I have no statement other than to say thank you very much to Dr. Ambler and director's staff. The National Bureau of Standards staff were so very nice to explain when I went down there, all the various functions. It certainly helped to understand more what each one of the program functions is.

There are a couple of questions, Mr. Chairman, and thank you for calling on me. It's a new position; I didn't realize I had to attend all of the various subcommittee meetings. I certainly appreciate your courtesy.

But one thing bothers me particularly. I have always felt that all of the research that we do in whatever laboratories there may be in the Federal Government ultimately has to end up benefiting someone. And that certainly has been the practice and the intent in the mission of the National Bureau of Standards. However, you're doing away with the office in 1986 that is—oh, that's in Commerce, but how is that going to affect what you do, the Office of Productivity, Technology, and Innovation? If we do away with that, how are we going to disseminate all of this great information that you're gathering?

Dr. **Ambler**. The kinds of things that OPTI does, that Dr. Merrifield does, the policy kind, business-related kind that he talked about earlier, and the kinds of things that the National Bureau of Standards does are more by way of specific technical things. We are a laboratory. And we deal with our peers in industry and universities, so the technology transfer that goes on from the National Bureau of Standards is a different kind.

Mr. **Lujan**. But wouldn't this office determine—like in your computer work over there—what are the needs out there so that you might pursue that? Or do you initiate that rather than going to industry and saying, "What are the things that you need to find out?"

Dr. **Ambler**. Well, we work with many different agencies in Commerce in things such as that, the various assessments that are made of the various industrial sectors. As far as our own knowledge goes, we feel that we are very intimately plugged into the scientific and technical developments as they will affect industry and we can do a pretty good job at predicting the relative importance to the economy as a whole.

Mr. **Lujan**. So that's how you set your priorities, by just direct contact with them and what they're going to need, and that's how you set the priorities in research?

Dr. **Ambler**. It's the job of every senior person at the National Bureau of Standards, from group leader all the way up to director, to know their counterparts in industry, know what's going on, and that is discussed constantly at all levels and the interaction goes on there. So as far as technical developments go, we feel pretty confident that we know what's going on.

Mr. LUJAN. Following up on that, industry has a great stake in what's done there at the Institute for Computer Sciences. Is there any way to get them more financially involved? I know that you have people that come and work with you, but more direct funding somehow or another to get industry to participate more in that type of work that you do over there?

Dr. AMBLER. We do, of course, in that area do cost sharing as we do in other areas. I think maybe Mr. Kammer has a few more specific points he could make for your question, if you will agree to that.

Mr. LUJAN. Yes.

Mr. KAMMER. Mr. Lujan, we have recently started probing some ideas to see if we can get industry to become more financially involved in some of the activities at the Institute for Computer Sciences and Technology because they are supporting it a lot now, they are very interested in it. We hope to have a proposal together soon, and we're going to brief the Department of Commerce, and we hope ultimately to be able to come and brief the Congress as well.

Mr. LUJAN. Very good, because it seems to me that they have a great stake, probably even bigger than the Federal Government does, in it. Those applications are directly beneficial to them.

Mr. KAMMER. I think that's exactly right.

Mr. LUJAN. Fine. Thank you.

Mr. BROWN. I would like to go back to the other members of the panel if I may. Would you indicate which ones you would like to testify, Dr. Ambler?

Dr. AMBLER. Dr. Lyons will go first.

Mr. BROWN. Fine.

Dr. LYONS. Good morning, Mr. Chairman. It's a pleasure to appear once again before the subcommittee to discuss the engineering programs of the National Bureau of Standards. I have a long statement for the record, if you please.

Mr. BROWN. Without objection it will be placed in the record in full.

Dr. LYONS. It is the role of the National Engineering Laboratory to conduct the engineering programs of the Bureau, to provide technical services to engineers, both private and public, as they apply scientific principles to the solution of real problems. These services include provision of engineering data, new engineering measurement concepts and techniques, calibrations, standard reference materials, and new engineering practices. And we add to the engineering knowledge base via a program of research to provide the intellectual basis for the other more applied efforts.

We establish and shape our programs in engineering by taking our cues from the marketplace. A decade ago the list might have looked like this: Measurements for integrated circuits on silicon wafers; response of materials to fire; data for the equity transfer of liquified natural gas; three-dimensional measurements of machine parts; and techniques for measuring energy conservation in buildings.

The analogous list today has on it: Services for optical communication; robotics and fully automated manufacturing; the application of computers to standards and codes, including the development and application of expert systems; and process engineering for biochemical manufacturing.

I would like to touch briefly on technical accomplishments from four elements of our programs. First, let me tell you where we stand on the new scientific computing system, which this subcommittee has been involved with for many years with us. In September 1984 we signed a contract with the successful bidder, the Control Data Corp., for a super computer, a front-end computer, and the associated peripherals and communications gear. We have for 1 year been preparing a new site at Gaithersburg to receive this hardware. All of the hardware arrived yesterday, and we have provided the subcommittee photographs which indicate that I at least have been downstairs and placed my hand on the new scientific computer.

We will be installing that hardware during the month of March, and we expect to turn on the switches on April 1. We should be in full operation by September 30.

This system will service six sites: the Bureau of Standards at Gaithersburg and Boulder, CO, the Environmental Research Laboratories of NOAA at Boulder, Miami, FL, Norman, OK, Seattle, WA, and Ann Arbor, MI, and the Institute for Telecommunications Sciences also at Boulder and part of NTIA.

Turning to electronics, I mentioned that we are increasingly receiving requests for services in optical communications. We have just completed a new measurement capability for attenuation and bandwidth for optical fibers at 1.3 micrometers, which is currently the wavelength of choice. And we have developed a new optical detector which operates at a pulse width of less than 22 pico-seconds, a pico-second being 10 to the minus 12 seconds, a short time.

In chemical engineering we have just issued new engineering data on water and steam, which is the most used of all the engineering data sets. This project was done jointly with the National Research Council of Canada. This is the publication. That's what a data set looks like [indicating]. It's also available in machine-readable form. And this has now been accepted by the International Association for the Properties of Steam. The principal thing that's new here is a better equation of state and covering wider temperature and pressure ranges.

In applied mathematics we have developed a new, faster algorithm for modeling molecular dynamics. This algorithm required the combined skills of computer science, applied mathematics, and physical science, and I think it's a model for what we'll be seeing in the future, particularly with the addition of our new supercomputer. It allows us to solve problems even beyond those that we could normally put on such a machine.

In our Automation Program, in June 1984 we ran another experimental run in the facility and demonstrated the validity of the hierarchical control architecture of the AMRF and also of the nonproprietary interfaces among the various computer control devices. The Automation Program has received over 3,000 visitors in the past year, has developed new projects with Boeing, Westinghouse, Martin-Marietta, IBM, and Acme Cleveland. Currently, we have 24 industrial research associates in this program and a like number of universities collaborating with us.

Dr. Ambler mentioned economic impacts. I would like to cite just three from the engineering programs, remembering that most of these impacts occur 5 or 10 years after the technical work is reported. For example, some years ago we developed resistivity standards for silicon wafers. It is now estimated that between $300 to $400 million per year are saved by the electronics industry from these resistivity standards.

We have developed a new, more economical and efficient way to calibrate antennas in the near field as opposed to out on far-field ranges. And in just one DOD contract, this technique provided savings of $6 million. There are many such antennas.

A contractor study requested by the Navy of the Automated Manufacturing Research facility shows that somewhere between one quarter to three-quarters of $1 billion in savings per year should be obtained from the technology simply in facilitating the installation of CNC machine tools in existing machine shops around the country.

Those are brief remarks, Mr. Chairman, on the engineering programs, and later I would be happy to answer your questions.

[The prepared statement of Dr. Lyons follows:]

U.S. DEPARTMENT OF COMMERCE
GAITHERSBURG. MD 20899
STATEMENT OF
JOHN W. LYONS, DIRECTOR
NATIONAL ENGINEERING LABORATORY
NATIONAL BUREAU OF STANDARDS
BEFORE THE
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
ON AUTHORIZATION OF APPROPRIATIONS FOR FISCAL YEAR 1986
FEBRUARY 26, 1985

U.S. DEPARTMENT OF COMMERCE

STATEMENT OF
JOHN W. LYONS, DIRECTOR
NATIONAL ENGINEERING LABORATORY
NATIONAL BUREAU OF STANDARDS

BEFORE THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
ON AUTHORIZATION OF APPROPRIATIONS FOR FISCAL YEAR 1986

FEBRUARY 26, 1985

Mr. Chairman and members of the subcommittee. It is a pleasure once again to appear before you to discuss the engineering programs of the National Bureau of Standards, to review recent accomplishments, and to summarize the proposed budget for each major program.

The National Engineering Laboratory conducts the engineering program of the National Bureau of Standards. The work of the engineer is to solve practical problems by the application of scientific principles. We are charged in our enabling legislation with providing technical services to industry, academe, and other government agencies. So, our assignment is to provide engineers in all these places with the technical tools they need: new engineering data, new measurement concepts and techniques, calibrations and reference materials, and new engineering practices including suggestions for changes in engineering standards and codes. To provide the intellectual basis for this work and to offer additional support to our clientele, we also conduct a program of fundamental research in a variety of engineering fields.

In establishing and shaping our programs we take our cues from the marketplace. As new technologies are born and grow up, needs for our services become clear. Examples from the last decade include measurements and data for silicon for integrated circuits, characterization of microwave antennas at higher and higher frequencies, measuring the response of synthetic materials to fire, concepts and models for energy conservation in buildings, improved data needed for equitable transfer of liquified natural gas, and measurement in three dimensions of machined parts. Today we are pressed to provide similar support for emerging technologies such as optical communications, robotics and fully automated manufacturing, the application of computers and artificial intelligence to standards and code writing, and process engineering for biotechnology.

It is exciting for us to move into these new high-technology areas at the frontiers. But there are many areas we support that are perhaps less glamorous but which are just as critical to the Nation's well being. We continue to provide measurement services to the electric power generation and transmission industry. The need for accuracy becomes even more critical as voltages go higher and therefore the value of the power transmitted increases. The measurements themselves are every bit as sophisticated as they are in the new industries. We remain the central reference laboratory for dimensional measurements, for flow calibrations, and for producing engineering data of improved accuracy and of broader range. This past year, for example, we published, jointly with our colleagues in Canada, new tables of data on steam, one of the most widely used of all engineering data sets. Many of the activities of this kind have been at NBS for a long time and will be here long after we are gone because of the continuing nature of the industrial endeavors they support.

One measure of our performance is the intensity and frequency of interactions with the private sector and the extent to which the private sector participates in our work. The outstanding example of this is in the automated manufacturing research program where we have equipment which has been loaned and donated by industry, research associates sponsored by a number of companies, guest workers from several universities, and several millions of dollars of support from the Department of Defense. This is only the most dramatic case; there are many others. Last summer we organized and hosted a conference on the use of supercomputers sponsored by several private firms and coarranged by Cornell, IBM, and Los Alamos, among others. We signed a cooperative research agreement with Lehigh University on developing measurements and related engineering techniques for scaling-up biochemical processes. We have been able to undertake, with support from the Gas Research Institute (GRI) and the American

Petroleum Institute (API), a multiyear program aimed at providing substantial improvement in the metering of natural gas and oil using orifice plates. In a jointly sponsored project with the Electric Power Research Institute, a mobile calibration system was developed to verify the accuracy of electric energy measurements at points where large amounts of energy are transferred, such as points of interchange among utility companies, states, and at international boundaries. This system has been transferred to industry. These are just a few instances of the relationships we maintain with those who can make use of our work. Technology transfer is more than a goal for our laboratory; it is an everyday reality.

The Subcommittee is well aware of our efforts to acquire a new central computer for NBS. In September we signed a contract with the successful bidder, Control Data Corporation, for a new central system at our Gaithersburg site. This consists of a Cyber 855 Series 180 "front end" computer, a Cyber 205 Series 600 supercomputer, and associated gear and peripherals. This supercomputing center will be installed in a newly prepared site during the next few weeks and is slated for start-up on April 1, 1985. The new computers are for use by NBS, the Environmental Research Laboratories of NOAA, and the Institute for Telecommunication Sciences of NTIA. We are installing communications to Boulder, Colorado; Miami, Florida; Norman, Oklahoma; Seattle, Washington; and Ann Arbor, Michigan, each of which has its own computer or computers for local processing but will utilize the Gaithersburg facility for large computations. All of this should be in place by the fall of this year with the result that NBS will be at the state-of-the-art in scientific computing.

Our success at NBS depends on our superb staff. It is difficult to acknowledge everyone but once in a while someone else does it for us. I mention here just two cases in point: Dr. Emil Simiu, civil engineer, was named by the National Society of Professional Engineers as the Federal Engineer of the Year for 1984, and Dr. James Albus, specialist in robot technology, received the Joseph E. Engelberger Award of the Robotics Industries Association (presented by the King of Sweden at a meeting in Stockholm).

I turn now to a review of those programs in NEL for which funding is proposed in FY 1986.

ENGINEERING MEASUREMENTS AND STANDARDS SUBACTIVITY

NEL's portion of this subactivity was funded in FY 1985 at $31,385,000 (500 positions). In FY 1986 the budget is estimated to be $26,889,000 (444 positions).

Electrical and Electronic Measurements

In FY 1985, this program was funded at $11,358,000. The FY 1986 budget continues this program at $11,103,000. Additional reimbursable support for the program in FY 1986 is expected to be about $9.9 million, including fees charged for NBS calibrations.

In this our largest program, we support the production of semiconductors, electric power generation and transmission, and manufacture of components for communications. We offer a broad range of measurement services and develop new techniques in response to industrial and governmental needs. The technology is fast-moving in both electronics and communications, requiring very close contact between our staff and the users of our services.

Recent accomplishments:

o We developed new measurement methods for characterizing very-large-scale-integration (VLSI) ceramic packages and for designing thermal test chips for use in such characterization. These methods are essential for the specification and evaluation of VLSI packages. We are receiving many requests for our computer model of thermal test chips from industry, which is using them to improve the quality and reliability of U.S.-manufactured semiconductor devices.

o We designed and assembled a computer-controlled spectroscopic ellipsometer which provides very accurate and precise measurements of thin films. This instrument has been used to measure semiconductor materials and to perform initial measurements on a prototype absolute step-height Standard Reference Material (SRM). This SRM will be used for calibrating measurements of thin insulating films critical for the manufacture of integrated circuits.

o We have now demonstrated constant voltage steps of up to 1.2 volts from a series array of 1500 Josephson junctions. This breakthrough indicates that there are no major barriers to the realization of a direct one-volt standard to replace the present rather complicated system based on a signal of a few millivolts. This will be very useful in calibration of high-precision electrical equipment.

o We have designed and fabricated an optical detector with a response time faster than 22 picoseconds. This powerful tool will be used for developing measurement methods to assess the performance of high-data-rate single-mode optical fibers for communications.

o We established the capability to measure attenuation and bandwidth of optical fibers at 1.3 micrometers. These are the principal parameters required for characterization of second-generation fibers now being adopted by the communications industry.

o We have developed two new electronic noise standards, one in the frequency range of 2 to 4 gigahertz, the other at 75 to 110 gigahertz. These standards will make it possible for industry and other government agencies to further the development and evaluation of critical components for microwave and millimeter-wave systems that are important in communications, defense, and aerospace.

The rapid growth and change in the technologies served by this program require constant reshaping of NBS' work. We are beginning to address needed services for faster electronic circuits based on gallium arsenide, for optical circuits, for optical fibers operating at higher bit rates and at longer wavelengths, and for millimeter wave communications and instrumentation operating in new frequency bands.

Chemical Engineering Metrology

In FY 1985 this program was funded at $4,599,000. The FY 1986 budget continues this program at $4,490,000. Reimbursable support for the program in FY 1986 is expected to be about $5.7 million.

Here we provide industry with the engineering foundation for reliable measurements and reference data that help the engineer to design, develop, and control chemical processes. This is important in order to evaluate innovative ideas for more efficient processes and to assure fair and equitable exchange of chemical feedstocks, fuels (oils and gas), and other commodities throughout the American economy. We emphasize support for three major segments: the chemical industry, the petrochemical industry and the segment making very high value-added products -- products from biotechnology and chemicals for the electronic industry, for instance. We provide a wide range of measurement services, instrument calibrations, and new procedures for accurately measuring and predicting the engineering properties of fluids and solids of importance in industrial chemical systems.

Recent accomplishments:

o In collaboration with the National Research Council of Canada, we published a new book of steam tables. This provides water and steam properties over a much wider range of pressures and temperatures than heretofore. The data have been accepted by the International Association for Properties of Steam. The tables will help scientists and engineers in designing power plants and chemical processes, recovering petroleum and minerals, designing heat transfer systems, boilers, dryers, and turbines, and in harnessing geothermal energy.

o Two of our scientists were granted a patent for a new acoustic flowmeter, useful in accurately measuring the flow of gases in industrial process gas streams and in automotive and aircraft applications.

o We produced a mathematical model to predict critically needed properties of fluid mixtures containing carbon dioxide. This work was sponsored by an industrial consortium of fourteen private firms. The data are needed for commercial exchange of carbon dioxide and for industrial design. Since carbon dioxide is being used as a recovery agent to extract crude oil from depleted fields and in food processing, industry is very interested in NBS' assistance in this area where the Bureau typically provides national leadership.

o A new NBS method of measuring particle temperature and particle motion in fluidized beds has been developed. Similar measurement techniques are being applied to full-scale recovery boilers and entrained-flow coal gasifiers in efforts to improve their operating efficiency. The method uses a unique quartz optic probe and should have important uses in the production of chemical feedstocks and fuels from coal.

o The American Society for Testing and Materials has adopted as a standard the NBS-developed tables of propane properties. These tables join those for methane and ethane so that the NBS research now provides the standard property data for the major constituents of natural gas sold in the United States. The data will be used in measurements for custody transfer of natural gas and for process design in a wide variety of chemical processes.

Looking ahead we are planning to address technical barriers to making measurements of physical and chemical process parameters during actual processing. We are starting to develop a set of technical tools to help engineers understand, scale up, and control emerging high technology processes, e.g., those in biotechnology, and various chemical processes when measurements at higher-than-normal precision and accuracy are needed.

Mathematical Sciences

In FY 1985 this program was funded at $5,665,000. The FY 1986 budget continues this program at $5,538,000. Additional reimbursable support for the program in FY 1986 is expected to be about $1.5 million.

The Mathematical Sciences program provides support in mathematical modeling, statistics, data analysis, systems analysis, and computing to the engineering and scientific programs of NBS and to a few other Federal agencies. The program develops mathematical methods in a host of mathematical subdisciplines working through extensive research collaborations with NBS scientists and engineers. The Center also provides technical assistance for NBS laboratory automation, operates the NBS NET (which links computers, word processors, and terminals throughout NBS) and operates the Bureau's central computer.

The expertise of this program in operating and supporting the central computer has been successfully applied to the problem of acquiring the new central computing system mentioned earlier.

Recent mathematical accomplishments:

o In a joint effort with the automated manufacturing research program, we developed a computer algorithm for planning the shortest path of a robot to move from one point to another on the floor of a room, avoiding all obstructions. This software is being used in the Automated Manufacturing Research Facility. Great economies of speed and computer size, as much as a factor of 10 or more, have been realized by the application of these modern mathematical methods of computational geometry.

o In a cooperative project with staff of New York University we developed a software package which expands the scope of problems which can be solved using mathematical techniques of integer programming. The new work enables users to determine the optimal allocation of resources among a discrete number of alternatives. The software has applications in manufacturing (e.g., scheduling production runs) and in scientific laboratories (e.g., planning experimental testing to obtain the most information at least cost).

o A radically new computational method was developed for the simulation of very large scale problems in molecular dynamics.

This method is specifically aimed at exploiting the vector processing capability of modern superconductors and has been successfully implemented on a CYBER 205 vector computer. Tests show that this method substantially exceeds the capability of any other known technique.

We expect the just-purchased supercomputer to stimulate development of other new mathematical techniques which will permit us to address ever more complex and difficult problems.

Automated Manufacturing Research

This program includes Automated Manufacturing Interface Standards, and Mechanical Engineering Metrology. In FY 1985 these programs were funded at $5,868,000. The FY 1986 budget continues this program at $5,758,000. We are benefiting from equipment loans from the private sector, research associates and visiting scientists, and substantial increased support by other Federal agencies, notably the U.S. Navy. Reimbursable support for the program in FY 1986 is expected to be about $10.6 million, including fees charged for NBS calibrations.

This program, now the fastest growing area of NEL, provides services to the manufacturing sector of the economy for automated manufacturing, robotics, dimensional measurements, and special measurement technology for very high-precision machining.

The automation program is addressing two critical problems: the need for measurement techniques suitable for a fully-automated production environment and the standards necessary to permit computer-controlled devices from different manufacturers to work together in a computer-integrated factory.

Recent accomplishments:

o In June 1984, we held the second major run of the Automated Manufacturing Research Facility. The run demonstrated the validity of the NBS control architecture which allows robots, machine tools and computers from different manufacturers to be integrated into a single manufacturing system by means of non-proprietary, data interfaces.

o As part of our technology transfer activities in FY 1984, we provided technical briefings on NBS' work in automated manufacturing to over 3,000 business executives, manufacturing managers, production engineers, and scientists.

o We have continued our extensive interactions with industry through the initiation of a number of new cooperative research projects in automated manufacturing. Some of the companies with whom we have begun joint research projects include:

- Boeing - applications of NBS automation work to their operations,
- Acme-Cleveland - sensors that predict when tools are wearing out,
- Westinghouse - robot control systems and diamond turning machines,
- Martin Marietta - to design a generic robot safety system that uses artificial intelligence, and
- IBM - to develop interfaces for integrating manufacturing databases with computer-aided-design databases.

Through FY 1984, there have been 24 industrial research associates working alongside NBS staff at the Automated Manufacturing Research Facility. These researchers are sponsored by their companies to work at NBS on mutually beneficial research.

- The NBS Hierarchial Control System Emulator was delivered to four industrial sites for testing and eventual adoption. This marks the first direct transfer of the NBS-developed control system software to industry. The emulator is a collection of computer programs designed to reflect accurately the structure of the Automated Manufacturing Research Facility. General Electric has adopted this system for their automated factory in Charlottesville, Virginia.

o A recent cost-benefit study done for the Navy by an independent economic analyst estimates that the savings to the economy attributable to the NBS automation program will be running $250 to $760 million annually within five years. These dollar savings result from only one of several potential sources, the more rapid introduction of computer-controlled machine tools into metal-cutting manufacturing attributable to the NBS work.

o The Valeron Corporation, a machine tooling manufacturer, installed the NBS-developed "drill-up" system for the Caterpillar Tractor Company, General Motors, and Ford Motor Company. This microprocessor-based system predicts failure of machine tooling used on numerical-controlled machining centers. It saves downtime and reduces defective items.

As the automated manufacturing research facility matures and is made available increasingly to outside researchers, we will turn our attention to two new areas - new technology for robotics, and new measurement science for very high-precision machining. The next problem in robotics goes beyond the fixed articulated arm now seen in factory automation to new mobile robots that work in harsh, hostile environments. We will adopt our control heirarchy and our sensing and activating technology for uses on the battlefield, in construction of buildings, ships, and space stations, and other challenging uses. Very high precision manufacturing has pushed past our capabilities with conventional measuring tools. We are starting to look at new scales of measurement at the subnanometer or atomic length scale. The techniques are needed, for example, for making special mirrors and for characterizing new, smaller integrated circuits.

Technical Reimbursable Services

This program is totally supported on a reimbursable basis and includes funding of about $3.0 million in FY 1986 for both the NBS Office of Energy-Related Inventions (OERI) and the NBS Law Enforcement Standards Laboratory (LESL). OERI evaluates inventions for technical validity, potential energy impact, and commercial feasibility and also conducts activities aimed at stimulating technological innovation by independent inventors and small business. LESL conducts research and provides technical services to assist State and local governments in procuring equipment suitable for the needs of law enforcement agencies.

Economic Impact

I would like to close by pointing out that the economic benefits from many of our program accomplishments do not become evident until several years after our research results, data and measurement methods and services have been transferred to the users. For example:

o NBS developed precise methods for measuring resistivity and accurate data for determining the density of "dopants" in silicon materials from measurement of resistivity. The relationship between resistivity and dopant density was adopted by 1982 as a national and international standard. The industry estimates that the NBS work on resistivity measurement improvement alone saved $30 million through reduced costs of marketplace transactions, and possibly $300 million through reduced manufacturing costs.

o In 1983 NBS completed the development of the first indoor, near-field planar antenna measurement method. Eleven major U.S. organizations have adopted the near-field scanning techniques for design and manufacturing control. The technique is being used to create a new generation of antennas designed to attain optimum performance in communications, military, and aerospace systems. The large financial impact on market transactions alone is indicated by a $6 million savings in a single Navy procurement, attributed to the near-field antenna measurement capability.

Mr. Chairman, this concludes my prepared testimony. I shall be pleased to answer any questions you, or other members of the Subcommittee, may have.

JOHN W. LYONS

Date of Birth: November 5, 1930

Birthplace: Reading, Massachusetts

Education: Degrees
Harvard University, A.B., Chemistry - 1952
Washington University, A.M., Physical Chemistry -1963
Washington University, Ph.D., Physical Chemistry -1964

Positions:
Director
National Engineering Laboratory
National Bureau of Standards

As Director of the National Engineering Laboratory, Dr.Lyons is responsible for NBS's research in applied mathematics, building technology, electronics and electrical engineering, energy conservation, engineering standards development, fire, manufacturing engineering, and chemical engineering.

From April to December 1983 Dr. Lyons served as the Acting Deputy Director of the National Bureau of Standards.

Dr. Lyons was Director of the NBS Center for Fire Research until December 18, 1977, and was responsible for providing scientific and technical knowledge applicable to the prevention and control of fires.

Dr. Lyons served in various research and development positions at the Monsanto Company from 1955 to 1973. He specialized in the chemistry and uses of phosphorus-based chemicals including fire retardants. He served from 1971 to 1973 as a member of the ad hoc panel of fire research, a National Academy of Sciences evaluation panel for the National Bureau of Standards.

Dr. Lyons is author of three books: *Viscosity and Flow Measurements*, *The Chemistry and Uses of Fire Retardant,* and *Fire*. He was co-author and editor of *Fire Research on Cellular Plastics.* He has contributed chapters to five other books and has written numerous papers and articles on technical or research topics. His early research interest was the physical chemistry of polyeletrolyte solutions, especially formation of complexes with metal ions. This work emphasized the behavior of inorganic polyphosphates and desoxy ribonucleic acid (DNA).

Dr. Lyons is a member of the National Academy of Engineering, a Fellow of the American Association for the Advancement of Science, a Fellow of the Washington Academy of Science, a member of the Naval Research Laboratory Naval Research Advisory Committee, a member of the Office of Science and Technology Policy Committee on Federal Laboratories, member of the American Chemical Society (past chairman of the St. Louis Section), member of the American Institute of Chemical Engineers and member of Sigma Xi. He serves on the Advisory Committee for Engineering, National Science Foundation; Advisory Council, College of Engineering, University of Maryland; Board of Directors, National Fire Protection Association. He served on a special committee of the Maryland State Board for Higher Education to study the needs for engineering education (1983-84). He was chairman of the Products Research Committee (1974-1979), a nine-member charitable trust administering a $5M research fund on fire research; co-chairman of the US-Japan Natural Resources Panel of Fire Research (1975-1978). He received the Presidential Management Improvement Award in 1977 and the US Department of Commerce Gold Medal, also in 1977. In 1981 he received the Presidential Rank Award of Distinguished Executive.

Mr. BROWN. Thank you, Dr. Lyons.

Mr. Burrows.

Mr. BURROWS. Thank you, Mr. Chairman.

Mr. BROWN. Your presentation should only be half as long as normal. [Laughter.]

Mr. BURROWS. I certainly appreciate your interest in the activities of the Institute of Computer Sciences and Technology. In carrying out the National Bureau of Standards Computer Science and Technology Program, we are continuing to follow the committee's direction to pursue areas that are vital to the productivity and cost effectiveness of the Federal Government as well as the private sector computer users and manufacturers.

As the committee has noted in the past, the development of standards for computer hardware and software benefits both industry and the Government. Indeed, I witnessed in the last 2 years a growing acceptance of this fact and greatly increased cooperation between the two sectors.

Uniform international standards help to preserve the competitive position of the U.S. computer industry and to expand the market for computer products and services. Users need standards to link off-the-shelf commercial products of different manufacturers and to make full use of staff training and skills. Computerization of complex processes greatly improves productivity, but standards are essential for connecting a variety of hardware and software systems to achieve that productivity improvement.

We are continuing to take an active role in developing the needed standards by supporting the voluntary consensus process in the national and international organizations. ICST participates in the work of more than 60 industry standards-writing committees. In many of these committees we provide the leadership and do a significant amount of the technical work that's needed to get the projects started and completed.

By directly working with the users and vendors, we help to bridge the gap between the users' need for compatible products and the vendors' capabilities to implement standard features in their products. We have been successful in getting standards developed and adopted because both groups trust our impartiality and our technical competence.

Standards are most effective when they are implemented in off-the-shelf commercial products rather than in products developed specifically for the Federal Government. It is in this area our cooperative work with industry and the users is especially important. Getting the necessary standards developed is just one step in a process toward off-the-shelf products. Just as important is getting those standards available in products and services.

ICST has a unique role in supporting the voluntary standards process. We have traditionally developed the test and measurement methods for ensuring that products and systems meet these increasingly complex standards. Tests developed by us in the past are now available for use by manufacturers to test their own products and thereby assure correct performance.

We continue to be called upon by other Federal agencies to perform technical work for them. In 1984 we received approximately $2.4 million for reimbursable work in a variety of areas, including computer security, software engineering, data base management, and the development of the network protocols. In 1985 the number will probably be about $3.5 million.

The last major component of our program that I would like to talk about is competence-funded research. We have three projects that address areas of emerging importance: global communications; knowledge-based systems—so-called expert systems; and high-performance computing. As you know, the proposed budget for fiscal year 1986 for ICST's activities is $5 million. At this level of funding, we will be able to continue only a portion of our current activities.

That concludes my statement.

[The prepared statement of Mr. Burrows follows:]

U.S. DEPARTMENT OF COMMERCE
STATEMENT OF JAMES H. BURROWS
.DIRECTOR, INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY
NATIONAL BUREAU OF STANDARDS

BEFORE THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
AUTHORIZATION OF APPROPRIATIONS FOR FY 1986
FEBRUARY 26, 1985

Mr. Chairman and Members of the Subcommittee:

We appreciate your interest in the activities of the Institute for Computer Sciences and Technology. In carrying out the National Bureau of Standards' computer science and technology program, we are continuing to follow the Committee's direction to pursue areas that are vital to the productivity and cost effectiveness of the Federal government, as well as private sector computer users and manufacturers.

In this statement I will cover a portion of the work done under our Congressional appropriation, the reimbursable activities that we perform for other agencies, and our "competence" funded research.

In the current fiscal year, ICST's budget authority is $10.0 million for computer-related research, technical advice, and standards. This work supports the goals of the Department of Commerce and the U.S. government to maintain a U.S. competitive position in international trade, to improve U.S. productivity, and to improve the Federal government's use of computer and telecommunications technology. Under its Organic Act, NBS provides technical support to industry, academia, government, and the general public. The Brooks Act, P.L. 89-306, under which ICST carries out specific computer-related activities, emphasizes Commerce's responsibility in the area of computer applications in the Federal Government.

As the Committee has noted in the past, the development of standards for computer hardware and software benefits both industry and government. Indeed, I have witnessed in the last two years a growing acceptance of this fact and greatly increased cooperation between the two sectors. Uniform international standards help to preserve the competitive position of the U.S. computer industry and to expand the market for computer products and services. Users need standards to link off-the-shelf commercial products of different manufacturers and to make full use of staff training and skills.

We are continuing to work with industry in developing needed standards by supporting the voluntary consensus process in national and international organizations. ICST contributes to the development of industry-wide standards by leading and participating in the work of more than 60 industry standards writing committees in organizations such as the American National Standards Institute (ANSI), the International Organizations for Standardization (ISO), and the Institute of Electrical and Electronics Engineers (IEEE). By working directly with users and vendors, ICST helps to bridge the gap between users' needs for compatible products and vendors' capabilities to implement standard features in their products.

The importance of standards as an aid to productivity improvement was highlighted last year at a press conference at the Department of Commerce when NBS, General Motors, and Boeing Computer Services signed a cooperative agreement to demonstrate how different computer manufacturers' equipment can be linked using international network standards developed with ICST assistance by the International Organization for Standardization and the

Institute of Electrical and Electronics Engineers. Robert A. Frosch, Director of the General Motors Research laboratories, said that GM believed it could double productivity through the computerization of design and manufacturing processes. To do this, though, GM needs the ability to use and connect a variety of computers of different sizes and capabilities from different manufacturers; therefore, standards are deemed essential.

International network standards continue to be important. A formal agreement to support a cooperative effort in this area was signed by Commerce Secretary Malcolm Baldrige, NBS Director Ernest Ambler, Boeing Computer Services Company President Robert L. Dryden, and General Motors Corporation Vice President Robert A. Frosch in April 1984. When he signed the agreement for the Department of Commerce, Secretary Baldrige said, "This is an important step toward computer compatibility. Involving both large and small companies, this project highlights the promise that industry-government cooperation holds, especially for high technology areas that are critical to the world economy. It is an appropriate way for government to help industry help itself." In July 1984, this cooperative effort by ICST, General Motors Corporation, Boeing Computer Services, and 13 computer manufacturers and communications companies culminated in a successful demonstration of two local area networks at the National Computer Conference, a major annual meeting and exhibit for computer professionals.

The success of the 1984 demonstration of standards can be attributed to a large extent to our laboratory work in developing test methods. Test methods are essential for measuring the performance and adequacy of software and hardware products. Since the products themselves are complex, the tests needed to assure that the products comply with specifications, that is, provide the services required and perform satisfactorily, are even more complex.

One of ICST's goals is to provide the protocols needed for the entire range of processing applications in networks including transmission of bulk data, sending and receiving electronic mail, and composing and transmitting documents. We are supporting the development of these needed standards in the international standards organizations and encouraging their implementation by U.S. companies.

ICST works closely with user groups that are encouraging vendor development of standards products. One such group is the MAP (Manufacturing Automation Protocol) users group who met at NBS in January. MAP is a set of standards specifications which allow computers used in industrial automation application to communicate with each other on their factory floor. ICST assisted GM in developing MAP, which is now supported by more than 100 companies.

As I have said before, standards are most effective when they are implemented in off-the-shelf commercial products, rather than in products developed specifically for the Federal government. It is in this area that our cooperative work with industry is especially important. Getting the necessary standards developed is just one step in the process toward off-the-shelf products. Just as important is getting those standards available in products and services.

In January, ICST held the eighth workshop for those companies that are cooperating in the implementation of international network standards.

There are now more than 80 companies involved. Together we are preparing a demonstration for Autofact 85, an industry conference on factory automation to be held in Detroit this November. Boeing Computer Systems and General Motors will demonstrate several different network technologies in conjunction with the computer manufacturers who will implement the connectionless internetwork protocol. ICST has been working with ISO for the past 2 1/2 years to develop the specifications for that standard.

As we did for the NCC demonstration, ICST will assist the participating organizations in applying the test methods that we have developed. The technology for these tests is based on laboratory work which automates the design-to-implementation, testing and performance measurement processes. This shortens the time needed to produce the tests and increases productivity. ICST will work with industry representatives so they can take the test methodology to their companies who can then advance and improve product development. Again, both suppliers and users benefit. To continue this successful cooperative testing, we are leading a new effort to establish a long-term globally distributed network. This network will interconnect private and public networks of participating organizations and support the development of network standards and protocol testing methods.

ICST has a unique role in supporting the voluntary standards process. We have traditionally developed the test and measurement methods for ensuring that products and systems meet increasingly complex standards. Tests developed by us in the past are now available for use by manufacturers to test their own products and thereby assure correct performance.

The transfer of technical information and technology is not a one way process. Through ICST's interactions with scientists, engineers, managers, and users from other organizations, we have learned a great deal about technology related problems and the successes that other organizations have had in solving those problems.

Productivity improvement can be achieved if the right technology is selected and applied effectively. ICST receives many requests from organizations for help in finding that right technology. We continue to respond to requests concerning the most pressing technology related problems that many government and industry organizations share.

In FY 1984 ICST received approximately $2.4 million for work done for other Federal agencies. Our expected other agency funding for FY1985 is $3.5 million. The FY1984 work included help to the Department of Energy in adopting risk management procedures for computer security, the National Aeronautics and Space Administration and the Department of Defense in developing sound software engineering practices, and the Military Sealift Command in the Navy Department in developing database systems. We continue to provide assistance to the Department of Defense in the development of network protocols. This work is provided through the use of our technical base to solve real application problems and to achieve direct transfer of technology.

An example of cooperative research to improve user applications is the work ICST is doing for the Nuclear Regulatory Commission (NRC). We are extending and improving an automated approach to analyzing vulnerabilities of computer systems in cooperation with the Los Alamos National Laboratory. The result will be a full-fledged risk analysis and management procedure and using "expert system" methodology. This personal computer based system for the NRC will be described in a publication and made available to other organizations.

I would like to close this statement with a brief summary of a few research projects. ICST's competence funding for research in FY 1984 was \$700,000 for two projects-one in global communications and one in the investigation of knowledge-based software development techniques. Both are proceeding well. We are jointly testing with COMSAT network protocol performance when computer data is transmitted by satellite. A transmitter on the NBS campus sends data to INTELSAT, a satellite positioned over the Atlantic Ocean, which beams the data back to COMSAT headquarters in Clarksburg, Md. The test started in November and will continue through June 1985. Our joint investigation will help us identify improvements needed in the protocol when it is used in the satellite environment.

In 1984, we started to investigate the performance measures that are needed to obtain comprehensive indicators of performance on high-speed computers. The traditional methods of predicting performance are not comprehensive enough for the new generation of fast computers. New techniques that cover languages, applications, and architectures are needed. This year we have received competence funding to consider the various components that must be measured and to develop the needed measurement techniques. We are working with industry and universities in this effort.

The proposed budget for FY1986 for ICST's activities is \$5 million. At this level of funding, we will be able to continue a portion of our activities. In other cases we will depend heavily on the computer industry and the various voluntary standards organizations.

Biography

James H. Burrows

Since May of 1979, Mr. Burrows has been the Director of the Institute for Computer Sciences and Technology, National Bureau of Standards, Department of Commerce. The Institute manages a governmentwide program of research, technical assistance, and development of standards and guidelines for computers and networks. ICST's activities are directed principally toward helping Federal organizations manage and use computers effectively.

From July 1972 until May 1979, Mr. Burrows was Associate Director, Office of Computer Resources, U.S. Air Force. As the Air Force's senior civilian manager for data automation, he was responsible for developing and implementing policies for ADP management, operations, procurement and standards utilization.

Prior to 1972, he directed the development of large information systems and data management projects for the MITRE Corporation and the Lincoln Laboratory in Massachusetts.

His professional activities include memberships in the Association for Computer Machinery, the Institute for Electronics and Electrical Engineers, the American Association for the Advancement of Science and the Data Processing Managers Association.

Mr. Burrows is the Vice Chairman of the American National Standards Institute, Information Systems Standards Board; a member of the University of Maryland Computer Advisory Board; Chairman of the Advisory Board on the Built Environment's Committee on Advanced Technology for Design and Engineering and a member of the Advanced Building Technology Council Program Committee of the Advisory Board on the Built Environment for the National Research Council. He is a former Chairman of the Federal Interagency Committee for Automatic Data Processing. He is also a member of the Advisory Editorial Board for COMPUTERS AND STANDARDS.

Mr. Burrows was born on February 6, 1926 in Williamsport, Pennsylvania, USA. He received a B.S. in Engineering from MIT in 1949 and a M.S. in Mathematics from the University of Chicago in 1951.

Mr. BROWN. Dr. Johnson.

Dr. JOHNSON. Thank you, Mr. Brown, and members of the subcommittee. I am very happy to be here today to discuss the programs and the priorities of the National Measurement Laboratory at NBS. In light of the time, I would like to present you with a very brief description of our laboratory this morning and then focus on budget-related issues, if I may. And I would also like to request that my full statement be submitted for the record.

The National Measurement Laboratory is responsible for maintenance, development, and dissemination of the Nation's primary physical and chemical standards of measurement.

Our major areas of scientific activity include fundamental physical and radiation research, chemical physics, and analytical chemistry. We also manage the three basic programs which market NBS services, standard reference materials, standard reference data, and calibrations. These are the programs that transfer the sophisticated measurement technology developed throughout NBS to the tens of thousands of large and small users in industrial, State, and Federal organizations. You heard Dr. Lyons' reference to these programs earlier.

We work very closely here with industrial groups, with other Government agencies, with professional societies, with standards organizations to ensure that appropriate and timely priorities are established for our services. I must comment that we seem to be on target, since our services are more in demand this past year than they ever have been in the past.

Appropriated funds that support all of the NML activities are included under the budget subactivity measurement research and standards, and total $35 million for this year. We anticipate another $23 million from reimbursable services to other Federal agencies and from goods and services sold to the private sector.

Our laboratory had 680 full-time equivalent employees this past year, and we enjoyed the labors of 212 guest workers, research associates and academic persons. These visiting scientists comprise a vital ingredient in the mix of research that we conduct and the services that we offer. And as Dr. Ambler pointed out earlier, most of them work at their sponsoring organizations' expense.

There are several examples cited in my full statement which are intended to connect our fundamental research to future services and to illustrate the effectiveness of our collaborative efforts with others. There is one accomplishment in particular from the past year that we are very proud of and I feel represents a landmark that is worth mentioning here this morning.

In June of 1984, this past June, the first State-operated regional facility for radiation calibrations was opened as a result of a joint effort between NBS scientists and the State of Illinois. Our work, done in partnership both with the Conference on Radiation Control Program Directors and the Illinois Department of Nuclear Safety, represents a pioneering effort to establish a national network of laboratories that are tied directly to NBS quality assurance procedures. Similar cooperative laboratories utilizing this very cost-effective way of disseminating NBS expertise are now under development in the States of South Carolina, Washington, California, and Arkansas.

Turning to budget issues, the National Measurement Laboratory proposes program expansion in two areas for fiscal year 1986: process and quality control, and in biotechnology.

New physical measurement services that directly impact process and quality control in high-technology industries remain at the top of our priorities. Last year we requested an expansion of $2.5 million and 20 positions to initiate new services in the five highest priority areas that were identified by a committee of industrial representatives. We were appropriated, as Dr. Ambler mentioned, $.56 million—$560,000—in the fiscal year 1985 budget. This money was used to fund the first two areas on our priority list. A portion of the funds was used to develop new x ray standards for quality assurance of radiation therapy measurements in regional laboratories and to improve measurement quality procedures which will link NBS to those laboratories in a manner similar to the way we are operating with the State of Illinois.

The remaining funds appropriated in fiscal year 1985 are being used to establish a new calibration facility at NBS for leak rate and vacuum standards. These calibration services are urgently needed by the manufacturing industries, the industrial research community, and also by national laboratories engaged in fusion and nuclear energy programs.

At this time we are requesting an increase of $1.9 million and 14 positions to expand our program of measurements for the next three projects in the process and quality control list: spectroradiometry, electrical impedance, and microwave measurements. As I emphasized in my testimony to you last year, the only way that we can meet our commitments to American industry and still maintain our services is through new resources. This increase will enable NBS to implement a new approach to spectroradiometric calibrations which will be based on solid-state detectors which we feel will revolutionize measurement quality assurance in the lighting, photographic, and electro-optical industries.

New demands for precision electrical and electronic instrumentation and test equipment really permeate the high technology and defense industries and a large segment of the manufacturing industries. Representatives from these industries have worked closely with us to identify their needs for new measurement services that are directly relevant to quality control operations. With the proposed new resources, NBS will meet their highest priority needs with measurement methods and standards for electrical capacitance and inductance measurements.

Industry has also made strong demands for additional services in the microwave measurement area. These are services that are important to advanced communications and to aerospace systems. The new resources that are proposed will also enable us to respond to the highest priorities here.

In the area of biotechnology, we are requesting an increase of $3 million and 28 positions to help develop a new program and offer new services and supporting research. The potential significance of biotechnology to the world economy is well recognized, reflected in many ways by the large number of small firms that have recently been established, for example, and by the major investments that are now being made by very large firms.

I think less well known is the fact that this technology is likely to become the most heavily dependent upon measurement among all the high technologies. And this, in fact, was one of the central findings that was included in a report that we recently completed at the request of the Senate Subcommittee on Science, Technology, and Space. This report, based upon discussions with many private and public sector organizations both large and small, and taking into account the conclusions of the report by the Office of Technology Assessment, underscored the demanding measurement requirements of all phases of research, development, and processing.

To meet these requirements, a measurement support system will need to be developed based largely upon physical and chemical measurements. Our report spells out the measurement research that we will undertake, the new services that we will offer, the groups with whom we will cooperate, and the benefits to be derived from our services.

Mr. Chairman, that concludes my oral comments. I would be very happy to respond to any questions when Dr. Schwartz is finished.

[The prepared statement of Dr. Johnson follows:]

U.S. DEPARTMENT OF COMMERCE
STATEMENT OF
DONALD R. JOHNSON, DIRECTOR
NATIONAL MEASUREMENT LABORATORY
BEFORE THE
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
ON AUTHORIZATION OF APPROPRIATIONS FOR FISCAL YEAR 1986

February 26, 1985

Mr. Chairman and Members of the Subcommittee. I am pleased to have an opportunity to discuss the research programs, services and budget of the National Measurement Laboratory of the National Bureau of Standards.

Introduction

The National Measurement Laboratory (NML) is responsible for maintenance, development and dissemination of the Nation's primary physical and chemical standards of measurement. In order to meet the needs of science, industry, and commerce, NBS must maintain scientific competence and experimental facilities capable of dealing with the state-of-the-art measurement in many areas of science. The major areas of scientific activity within NML include fundamental physical and radiation research, chemical physics, and analytical chemistry.

The National Measurement Laboratory also manages, and is a major contributor to, the three basic programs which market NBS services - Standard Reference Materials (which permit others to relate their own measurements to certified standards), Standard Reference Data (which provide critically evaluated information on the chemical and physical properties of materials) and Calibrations (which permit others to relate their apparatus to national standards). These programs transfer the sophisticated measurement technology developed at NBS to the tens of thousands of large and small users in industry, state, and Federal organizations. We work closely here with industry groups, government agencies, professional associations, and standards organizations to ensure that appropriate and timely priorities are established for our services.

During FY1984 the National Measurement Laboratory had 680 full-time equivalent employees and enjoyed the labors of 212 guest workers, industrial research associates and academic persons. Most of these scientists work at their sponsoring organizations' expense and are a vital ingredient in the mix of research we conduct and the services we offer. Our appropriated budget under the subactivity, Measurement Research and Standards, for FY1985, is $35 million and we anticipate another $23 million for reimbursable services to other Federal agencies and for services and goods sold to the private sector.

The National Measurement Laboratory is engaged in a great variety of technical activities in each of its four major research units. Fundamental research carried out in these units provides the underpinnings for future generations of primary standards and services.

In the Basic Standards area we are responsible for maintaining and improving the national standards which underlie measurement science: mass, length, time, temperature, and electric current. Basic experimental and theoretical research is conducted here to build a stronger and more accurate foundation for physical measurements and to improve understanding of the phenomena on which physical measurements are based. A variety of new measurement services are made available to the public as the results of these technical activities mature.

For example, in the area of time and frequency the NBS technical reputation ranks with the best in the world. In recent developments, NBS scientists have demonstrated that simple ions can be trapped and cooled with lasers to reduce their random motions. These trapped and slow moving ions become an ideal basis for a new generation of primary frequency standards. Isolated ions hold promise of relating standards to fundamental atomic properties in a way that is minimally affected by the influence of the outside world. NBS has recently developed and evaluated the world's first cooled ion frequency standard. Although much work remains to be done before the Nation's primary time standard will be based on cooled ion technology, the recent demonstration makes it clear that some of the most serious limitations of existing atomic frequency standards can be overcome. This work has additional potential for significant payoff in other areas since much of modern science depends on atomic and molecular properties.

In the radiation area we are responsible for providing technology for the measurement and understanding of the effects of radiation in all areas including nuclear, ultraviolet, optical, infra-red and plasma radiation. Our fundamental research in electron physics and nuclear structure, as well as our work in ionizing radiation help to provide a basic understanding of the interaction of radiation with matter. The results of these research activities are applied in several areas including public health and safety, space exploration, pollution control, energy research, defense, industrial processing and advanced telecommunications.

NBS has worked closely with industry for many years to provide standards and measurement assurance services for ionizing radiation users, particularly in medicine and radiation protection. Recent increases in the use of ionizing radiation in other industrial sectors demands an improved knowledge of radiation effects as well as more accurate and reliable measurement. The development of new devices for measuring radiation dose at NBS during the past couple of years represents an important breakthrough in the field of dosimetry. NBS standard dosimeters are now being used to ensure quality measurements in areas such as radiation processing, radiation sterilization, and in the study of radiation effects on materials and biological systems. Specific applications worthy of note include:

- NBS designed fiber optics dosimeters are now commercially available and are used in the radiation processing of food.

- Radiochromic films are being used for dose distribution mapping in cancer therapy and industrial radiation processing.

- Radiochromic dosimeters are being used in a great variety of radiobiological studies - cellular survival, radiation genetics, irradiated animal mortality, and treatments of fruits for medfly or oriental fly infestations.

In Analytical Chemistry we provide measurement methods and standards for high accuracy chemical analysis and serve as the Nation's reference laboratory for chemical composition measurements. More than 30 billion chemical analyses are performed each year in the U.S. Our research in this area leads to methods and standards to ensure the quality of these measurements in areas ranging from clinical chemistry to metals processing.

For example, at the frontier of analytical chemistry is the need to develop chemical sensors and techniques that allow rapid identification of specific organic and organometallic compounds in a variety of settings. We expect our fundamental research in electrochemistry to form a basis for novel approaches to the analysis of these organic systems. Our research has already demonstrated that electrochemical techniques have the potential for selectively characterizing organohalides (such as ethylene dibromide) important in agricultural and environmental sectors. Electrochemical sensors, with the appropriate molecule-specific interface, could well form the basis for a new generation of biosensors.

Our activities in chemical physics focus on chemical properties and processes in surface science, chemical kinetics, thermodynamics, and molecular spectroscopy. These efforts lead to the development of advanced measurement techniques and improved understanding of the molecular foundations of complex physical and chemical systems. Research results from this program find application in many areas including the safe use of hazardous chemical materials; the design of energy efficient processes; the development of lasers; and environmental monitoring.

An exciting new challenge faces our Chemical Physicists in the area of molecular structure where NBS has long enjoyed a reputation for world class work. Current interests in complex chemical and biological systems have prompted us to extend our techniques to structures of very large biologically active molecules such as proteins. We are bringing NBS experimental facilities using neutrons and x-rays together with our extensive computer modeling capability to build a base of information relating structure to function in this important class of molecules. The experimental techniques and computer codes that we are developing here will find wide use in many areas of industry.

FY1984 Accomplishments

We believe that it is important to emphasize that much of our research is performed in collaboration with other organizations. A few recent examples of accomplishments through joint efforts with others will serve to illustrate the effectiveness of this direct means of transfer of NBS technology to those in industry and the private sector who will enjoy its benefits.

- Collaborating with NASA, we developed a new method for three dimensional imaging of objects using x-rays or gamma rays. This method has promise for application both in nuclear medicine and industrial quality control.

- The first state-operated facility for radiation measurements was opened this past year as the result of a joint effort between NBS scientists and the State of Illinois. Our work, done in partnership with both the Conference of Radiation Control Program Directors and the Illinois Department of Nuclear Safety represents a pioneering effort in establishing a national network of laboratories tied directly to NBS quality assurance services. Similar cooperative laboratories utilizing this cost effective way to disseminate NBS expertise are now under development in South Carolina, Washington, California and Arkansas.

o Our scientists designed and developed a new time transfer technique for users requiring the highest possible accuracy for timing applications. This technique utilizes satellite signals from the DOD Global Positioning System (GPS) and enables the full accuracy of the NBS primary frequency standards and atomic time scale system to be transferred on a global basis. The technique is now used as an important tool by the International Time Bureau in its construction of various international time scales.

o A new analytical electrochemical system was designed at NBS using flow-injection and a vibrating microelectrode which will permit trace levels of inorganic chemicals to be measured. This is a significant advance in the technology and was selected by Research & Development magazine as one of the "100 most significant" new technical products of the year.

o Collaborating with scientists from Intel Corporation, our scientists measured the concentration distribution of sodium in semiconductor devices using the Bureau's unique neutron depth profiling (NDP) facility. This will help industry design and evaluate state-of-the-art microcircuitry.

- Collaborating with Pratt and Whitney Aircraft and the University of Illinois, our surface scientists characterized the fine features of certain nickel-based alloys (super alloys) using the atom probe field ion microscopy (APFIM). This work is helping to advance the development of super alloys for use in jet aircraft engines.

- NBS conducted 13 courses on the principles and practices of quality assurance for chemical measurements. Courses were held at ten strategic locations around the country so that people involved with chemical measurements from a variety of scientific and industrial sectors could attend. These training courses are conducted by NBS on a completely reimbursable basis. More than 1000 people attended during FY1984.

- We hosted a workshop on the effect of computers on the generation and use of technical data. The workshop, attended by more than 150 people, addressed new opportunities the computer affords in making technical data more accessible. This is critical in applications such as the design of efficient processing systems and the development of advanced materials. Experts from industry and professional societies stressed the importance of data reliability and standardization in computerized data systems so that the fruits of more than $200 billion invested each year in research and development around the world can be used by hundreds of thousands of large and small firms in the U.S.

- In keeping with the need for numerical Standard Reference Data Bases, we completed two new products for on-line users in the chemical industry. One is a tape containing the NBS Chemical Thermodynamics Data Base which provides properties for any of the 14,000 chemical substances listed. The other is a tape containing data and search software for important industrial chemicals, prepared under a joint project with more than 40 industrial organizations.

FY1986 Proposed Budget Increases

The National Measurement Laboratory again proposes program expansion in two areas for FY1986: Process and Quality Control Measurements and Biotechnology.

New Physical Measurement Services from NBS that directly impact process and quality control in high technology areas remain high in the priorities of U.S. industry. Last year we requested an expansion of $2.5 million and 20 positions to initiate new services in the five highest priority areas identified by a committee of industrial representatives. We were appropriated $0.56 million in the FY1985 process to fund the first two areas on the list. Part of these funds is being used to develop new standards for x-ray quality assurance in secondary laboratories. We are also working with several states to develop regional radiation calibration laboratories, and to improve measurement quality procedures which will link NBS to those laboratories. The remaining portion of the funds is being used to establish a new calibration facility at NBS for leak rate and high vacuum standards. These services are urgently needed by the manufacturing industries, the industrial research community, and by national laboratories engaged in nuclear and fusion energy programs.

At this time we are requesting an increase of $1.9 million and 14 positions to expand our program of measurements for the next three projects on the process and quality control list: spectroradiometry, electrical impedance and electronic noise measurements. As I emphasized in my testimony to the Committee last year, the only way we can meet our commitments to American industry and maintain our current services -- which are still in great demand -- is through new resources. This increase will enable NBS to develop and deliver new measurement techniques and supporting services to meet the needs in these three areas.

There are three major trends in American industry that are placing significant new demands on NBS measurement capability. One is the increased use of high technology in the manufacture of sophisticated products; the second is the emphasis on process and quality control to ensure that the specifications required for proper performance of these products are met throughout the production process. New demands for precision electrical and electronic instrumentation and test equipment permeate the high technology and defense industries and a large segment of the manufacturing industry. These industries have worked closely with us to identify their needs for new measurement services important to their quality control operations. With new resources, NBS will meet their highest priority needs with measurement methods and standards for electrical capacitance and inductance and microwave power important to advanced communications and aerospace systems.

The third major trend in American industry is the movement to industrialize the recent revolution in biological science or biotechnology. In biotechnology, we are requesting an increase of $3 million and 28 positions to develop a new program and offer new services supporting research, development, and commercialization. The potential significance of biotechnology to the world economy - reflected in the large number of small firms recently established, and major investments by larger firms -is by now quite well known. Less well known is the fact that this technology is likely to become the one most heavily dependent upon measurement among all high technology areas. This was one of the central findings included in a report we recently completed at the request of the Senate Subcommittee on Science, Technology, and Space. This report, based upon discussions with many private and public sector organizations - large and small - and taking into account the conclusions of the report by the Office of Technology Assessment, underscored the demanding measurement requirements at all phases of research, development, processing, quality assurance, occupational health and safety, environmental monitoring, regulatory approval, and trade. To meet these requirements, a measurement support system will need to be developed based largely upon physical and chemical methods. Such a system is not now in place, and without support from NBS, the voluntary standards apparatus of the U.S. will be hard pressed to meet the new requirements in a timely fashion. Our report spells out the measurement research we will undertake, the new services we will offer, the groups with whom we will cooperate and the benefits to be derived from our services.

Conclusion

Mr. Chairman, members of the Committee, the National Measurement Laboratory is ready to provide the technical leadership necessary for the development and dissemination of physical and chemical measurement services to meet the needs of science, industry, and government. I'd be happy to respond to any questions you may have. Thank you.

Dr. Donald R. Johnson
Director, National Measurement Laboratory
National Bureau of Standards

Don Johnson was appointed Director of the National Measurement Laboratory in March 1983. He is responsible for the development and maintenance of the scientific competences and experimental facilities necessary to provide the United States with a central basis for uniform physical and chemical measurements, measurement methodology, and specifications of properties that determine the performance of materials.

Dr. Johnson began his career at NBS in 1967 as a physicist performing basic research on the development of instrumentation and techniques for studying short-lived molecules in complex chemical systems for application in physics, chemistry, aeronomy and radioastronomy. Dr. Johnson has been directly involved in numerous radio telescope observations and participated in the discovery of several new interstellar molecules.

In 1976, he served as Program Analyst in the Office of the NBS Director where he analyzed and evaluated scientific and technical programs in the context of Bureau, Departmental, and Administration policy and provided recommendations to the NBS Director on basic standards and fundamental physics activities within NBS.

Dr. Johnson became Deputy Director for Programs in the National Measurement Laboratory in 1978 to provide direction for the matrix managed Programs of the Laboratory, and in 1980 was appointed Deputy Director for Resources and Operations where he directed the five major technical Centers of the Laboratory.

Dr. Johnson received a Bachelors Degree in Physics from the University of Puget Sound in 1960, a Masters Degree in Physics from the University of Idaho in 1962, and a PhD in Physics from the University of Oklahoma in 1967. He has authored (or co-authored) over 60 original scientific papers and presented many invited talks.

Dr. Johnson has received numerous awards, including both Silver and Gold medals from the Department of Commerce, the Arthur S. Flemming Award and the Senior Executive Service Meritorious Award.

He serves on the Board of Directors of the American Society for Testing and Materials. He currently chairs the ASTM Standing Committee on the Technical Committee Activities and a special Task Force on Standards Technology Training. Dr. Johnson is a fellow of the American Physical Society and represents the Division of Chemical Physics on the APS Council. He is a member of the American Association for the Advancement of Science, the American Astronomical Society, the International Astronomical Union, and the Sigma Xi.

Mr. **Brown**. Thank you, Dr. Johnson.

Dr. Schwartz.

Dr. **Schwartz**. Mr. Chairman, members of the subcommittee, I thank you for this opportunity to describe some of the accomplishments and plans of the Center for Materials Science of the National Bureau of Standards. It has become almost a cliche to argue that the health of the U.S. economy lies in an increasing dependence on our technological advantages.

But facts are facts, and the facts are nowhere so clear as in the area of advanced materials. It is the task of the Center for Materials Science to assist industry and government in maintaining that technological edge, particularly in the areas of measurement of structure and properties, accumulation and verification of materials property data, and provision of well-characterized standard materials. In this task we depend upon the maintenance of cutting-edge research activities to anticipate, rather than follow, the new developments.

My written testimony submitted for the record includes details of several of our recent accomplishments. For example, we have moved strongly into the area of materials data base development in collaboration with industry. Just yesterday [February 25, 1985] Secretary Baldrige joined the American Society for Metals in a joint conference to announce the completion of the society's fundraising drive to finance their portion of a cooperative program to develop a metal alloy phase diagram data base.

In another area, the joint NBS and American Iron & Steel Institute effort to develop sensors for the steel industry is making significant progress. We transferred 2 months ago, some successful elements of our program to scientists at the Argonne National Laboratory for further development toward commercialization.

Turning now to our plans for the future, I am delighted that our proposed budget for 1986 includes funds to initiate construction of a cold neutron research facility at the NBS research reactor, which will open up to U.S. scientists a tool for structural characterization which has been dominated for a decade by European scientists.

Neutrons, cool as in our proposed facility, are best suited for studying the molecular structure of polymers, the defect structures in advanced ceramics, the protein conformations in biomolecules, the defects causing failure in metallic structures, sensitive depth profiling of defect concentrations in semiconductor devices, and a host of other structural features of advanced materials. Such studies cannot be properly made by any other means.

For the last decade American scientists could participate in research using high intensities of cold neutrons only by traveling to Grenoble, France, where a limited amount of time on the joint French-German-British reactor was available to them after the needs of member nations had been met. In this and other European reactors, more than $140 million in capital costs has been committed to cold neutron research. In recent years, increased demand for the most frequently used experimental instruments has virtually frozen out the U.S. scientists from continued use of the Grenoble reactor.

A recent National Academy study of large materials research facilities has accorded its highest priority to the immediate development of a cold neutron facility for the United States to address this critical gap in our scientific and technological support capabilities.

The proposed facility at NBS represents the best opportunity to meet these needs in a timely and cost-effective manner. The proposed fiscal year 1986 budget would allow us to start developing a facility which will include 15 experimental stations. At least four of these would be financed by industry and universities which, with NBS scientists, would form participating research teams to develop those specialized techniques of particular need.

We have received strong expressions of interest in joining such teams from a number of companies. These are testimonials to the anticipated impact of this project on the industrial community.

As a former university professor, I have personally used the neutron scattering facilities of this country at two Department of Energy laboratories and at NBS. Furthermore, I have recently seen the facilities at Grenoble and studied their extraordinary capabilities. I echo the frustration of my colleagues, the U.S. materials scientists, at the increasingly uncompetitive position in which they find themselves in this important area of materials research, and express my optimism about the future—if we are encouraged to proceed with this facility.

Among the exciting new opportunities in advanced materials, one area is certain to receive special attention in all technologically advanced nations, the area of advanced ceramics. These materials offer the promise of operation of engines and turbines at extreme temperatures with dramatic reductions in energy consumption. They are already used as substitutes for metal tool bits, bringing improved performance, higher tolerance machining, and lower replacement costs. They are used in many forms in the electronics industry, most commonly as substrates upon which the silicon chip is mounted. They will have applications which take advantage of their resistance to wear, corrosion, and heat, and they will have specialized applications utilizing their unusual optical, electrical, and magnetic properties.

In only one rather unsophisticated application, ceramic machine tool bits, a study recently completed for NBS indicates a U.S. demand potential of $160 million per year by the year 2000 and an estimated savings in machining costs resulting from substitution of tungsten carbide by ceramics of $533 million in that year.

The major technical barrier impeding competitive commercialization of advanced ceramics is the inability to produce components reliably and reproducibly. In no other materials save those used in advanced microelectronics is performance and reliability so sensitive to small structural and chemical defects introduced during processing or in use.

The relationships between these structural features, the processing variables, and the resulting inservice performance and durability, are not understood. The President's 1986 budget contains a request in the amount of $3.5 million for NBS to provide the critically needed measurement methods and standards, key data, and predictive concepts required to ensure the reliable performance of advanced ceramics.

In closing, it is useful to note, as reviewed in a recent Washington Post article, that Japan controls 50 percent of the current $4.1

billion market in advanced ceramics. One company alone, Kyocera Ceramics, controls more than 60 percent of the world market for ceramic integrated circuit substrates. Another company, Toshiba, targets commercialization of ceramic diesels in the late 1980's and gas turbines in the 1990's. It is not too strong a statement to make that the time for action in this field is now.

I will be pleased to answer any questions the subcommittee may have.

[The prepared statement of Dr. Schwartz follows:]

U.S. Department of Commerce
Statement of Lyle H. Schwartz
Director, Center for Materials Science
National Bureau of Standards
before the
Subcommittee on Science, Research and Technology
of the
Committee on Science and Technology
U.S. House of Representatives

February 26, 1985

Mr. Chairman, Members of the Subcommittee:

I thank you for this opportunity to describe some of the accomplishments and plans of the Center for Material Science of the National Bureau of Standards.

Introduction

It has become almost a cliché to argue that the health of the U.S. economy lies in an increasing dependence on our technological advantages--but facts are facts and the facts are nowhere so clear as in the area of advanced materials. It is the task of the Center for Materials Science to assist industry and government in maintaining that technological edge, particularly in the areas of measurement of structure and properties, accumulation and verification of materials property data, and provision of well characterized standard materials. In this task our success depends on the maintenance of cutting-edge research activities to anticipate rather than follow the new developments. In my remarks today I will describe some of the recent accomplishments of the Center for Materials Science and then draw your attention to our plans for the future in two exciting areas.

Materials Data Bases

The selection of materials, the control of their processing and their ultimate in-service use depend on the availability of reliable data about their properties. Your committee report (H. Rept. 98-650) which accompanied our Authorization Bill last year stressed the importance of NBS' role in the development of a national resource of materials data. We recognize our responsibility here and are moving to respond to the data needs of our technologically based economy. The microcomputer revolution now allows us to place these data bases at the very fingertips of practicing engineers--once the data is collected, evaluated and tabulated. New advanced materials require more data than can be practically measured, and here again the computer comes to our aid, enabling us to model existing data and extend data to unmeasured, more complex materials. As two examples of data base development in the Center for Materials Science, I'll describe our work in phase diagrams and in corrosion data.

Materials properties depend critically on their structures. These structures may be modified to produce desirable properties by controlling process variables. Phase diagrams are the materials engineer's road maps in his selection of appropriate process variables. Following Dr. Ambler's guidelines for cooperation and cost sharing, CMS is working with three of the prominent U.S. professional societies, the American Society for Metals, the American Ceramic Society and the Society of Plastics Engineers, to develop phase diagram data bases for metals, ceramics and polymers. The NBS role is to evaluate the data and develop computer techniques for better dissemination of this information. The actual task of dissemination will be carried out by the professional societies.

The best test of the importance and value of the Bureau's work is industry's response to this program. Yesterday (February 25, 1985) the American Society for Metals announced with Secretary Baldrige the successful completion of a $4 million fund-raising drive to finance their portion of this cooperative program. The more recently initiated fund-raising effort of the American Ceramic Society has already netted more than $1 million from industry, and similar efforts of the Society of Plastics Engineers are in the planning stages. I should note that the major portion of these industry contributions will support the evaluation of data, largely in U.S. universities. These funds further provide for research associates who work with NBS scientists at the Bureau helping to ensure that our efforts are directed along lines of greatest relevance to the ultimate users of the data.

Another example of data base development in the Center for Materials Science is a cooperative effort with the National Association of Corrosion Engineers (NACE). A study, initiated by NBS in response to a Congressional directive (Senate Report 94-328), and carried out in cooperation with Battelle Memorial Institute, estimated the annual cost of corrosion to the nation's economy to be $167 billion (1985 dollars). These costs can be reduced by an estimated 15%--$25 billion--through the application of known corrosion control practices. This goal can be achieved by making evaluated rate and stability corrosion data more accessible to designers, engineers and scientists. In a cooperative effort with industry, the NBS Corrosion Data Center is concerned with the collection and evaluation of this data, while NACE will be primarily responsible for its dissemination. The central focus of the program is the establishment of an evaluated corrosion data base which can be easily accessed to provide the user with the required data in any of a number of possible graphical or tabular formats (attachment 1). As with the phase diagram programs, a NACE-sponsored Research Associate working at NBS is developing dissemination methods. His salary and an expanded nationwide program will be financed by industry via a NACE funding effort currently in the planning stages.

Sensors for the Steel Industry

This Subcommittee heard last year of the cooperative program between NBS and the American Iron and Steel Institute (AISI) in the development of process control sensors for the steel industry. At that time you were told of a program started at NBS to develop broadly applicable measurement methods for rapid, on-line determination of internal temperature distribution and detection of porosity in steel. This program is aimed at reducing energy consumption and improving quality and yield for U.S. steelmakers. I am pleased to be able to report that significant advances have been made in both studies, and that proof-of-concept is now being tested for the porosity sensor. At a meeting held at the Argonne National Laboratory in December 1984, NBS scientists described the positive results of their development of porosity sensors and turned elements of this project over to the Argonne scientists who will work with NBS and two small private industrial firms and the AISI to move this technology from the laboratory scale to plant application. One of the noteworthy features of this project is the involvement of the steel industry from the earliest stages by having AISI-sponsored research associates from steel companies work hand-in-hand with NBS scientists and engineers. This industrial involvement not only helps to keep our scientists on the right track, but ultimately speeds technology transfer. Currently five such researchers from U.S. Steel, Bethlehem Steel, American Iron and Steel Institute, Armco and Republic are working at NBS.

Cold Neutron Research Facility

The relationship between a material's structure and its properties is at the heart of materials science; techniques for processing which control that structure to produce desirable properties are the essence of materials engineering. I am delighted that our proposed budget for 1986 includes funds to initiate construction of a new facility at the NBS research reactor which will open up to U.S. scientists a tool for structural characterization which has been dominated for a decade by European scientists. I refer to the proposed Facility for Cold Neutron Research.

Why cold neutrons? Structural determinations are best facilitated when the wavelength of the radiation used matches the size of the structure studied. Neutrons usually coming from the reactor have a wavelength matching atomic size and are ideal for studying atomic structure. Neutrons, cooled as in our proposed facility, have longer wavelengths, better suited for studying the molecular structure of polymers, the defect structures in advanced ceramics, the protein conformations in biomolecules, the defects causing failure in metallic structures, and a host of other structural features of advanced materials. Such studies cannot be properly made by any other means. Furthermore, the proposed facility will allow studies of the motion of molecules on chemical catalysts, the slow molecular motions which determine the properties of polymers and biological materials and sensitive depth profiling of defect concentrations in semiconductor devices in a nondestructive manner. Examples of applications of cold neutron characterization and affected industries are listed in attachment 2.

In these and many other applications, the cold neutron studies allow nondestructive analysis due to the high penetrating power of neutrons. In many instances, the expected results will allow the development of primary standard reference materials which will be used for calibration of secondary test methods.

For the last decade American scientists could participate in research using high intensities of cold neutrons only by traveling to Grenoble, France, where a limited amount of time on the joint French-German-British reactor was available to them after the needs of member nations had been met. In this and other European reactors more than $140 million in capital costs has been committed to cold neutron research. Moreover, the Japanese have recently approved funding for a large cold neutron facility north of Tokyo. In recent years increased demand for the most frequently used experimental instruments has virtually frozen out the U.S. scientists from continued use of the Grenoble reactor. As one example of the impact of unavailability of facilities, I note small-angle-neutron scattering, a technique best done using very cold neutrons. In the 1970's, that technique stimulated dramatic advances in our understanding of the structure of polymers and biomolecules--key materials in major growing technologies. But almost all of the experimental work on these important problems has been done in Europe. Without a fully instrumented cold neutron facility the U.S. position will remain inferior to the European competition and be unable to match the newly funded facilities in Japan. A recent National Academy study of large materials research facilities has accorded its highest priority to the immediate development of a cold neutron facility for the U.S. to address the critical gap in our scientific and technological support capabilities. The proposed facility at NBS represents the best opportunity to meet these needs in a timely and cost effective manner.

The FY 1985 NBS budget contains funding at $1.5 million for the installation of a cold source and related research at the NBS reactor. We expect to install that source this Spring. Coupled with the recent doubling of the power of the NBS reactor, the elements are now in place for establishment of a world-class Cold Neutron Research Facility which would bring to U.S. scientists the capabilities for studying advanced materials now primarily reserved to Europeans.

One of the wonderful properties of cold neutrons is their ability to be conducted down guide-tubes to a location remote from the reactor face. This leads to a much more efficient use of the neutrons by construction of many experimental sites rather than the two which will be placed at the NBS reactor later this year. The proposed budget would allow us to start developing a facility which will include fifteen experimental stations. At least four of these would be financed by industry and universities which, with NBS scientists, would form participating research teams to develop those specialized techniques of particular need. We have received strong expressions of interest in joining such teams from a number of companies. These are testimonials to the anticipated impact of this project on the industrial community. The remaining eleven instruments are included in the planned budget for FY 1986 and subsequent years. Two thirds of their use would be made available to U.S. scientists on a competitively reviewed proposal basis.

As a former university professor I have personally used the neutron scattering facilities of this country at two Department of Energy Laboratories and at NBS; furthermore, I have recently seen the facilities at Grenoble and studied their extraordinary capabilities. I can echo the frustration of the U.S. materials scientists at the increasingly uncompetitive position in which they find themselves in this important area of materials research, and express my optimism about the future if we are encouraged to proceed with this facility.

Advanced Ceramics

A quiet revolution is underway. New materials unimagined only a few years ago are now or will soon be at the disposal of the design engineer--and with these materials come new opportunities of major strategic and domestic importance: opportunities for greater structural stability at lighter weight--e.g., composites for the aircraft and space industry; opportunities for unusual materials properties--e.g., man-made microstructures in the electronics industry; opportunities for increased resistance to wear and corrosion--e.g., unusual surface coatings and process treatments. Among all of these new opportunities, one area now seems destined to receive special attention in all technologically advanced nations--the area of advanced ceramics. These materials offer the promise of operation of engines and turbines at extreme temperatures with concomitant dramatic reductions in energy consumption. They are already used as substitutes for metal tool bits bringing improved performance, higher tolerance machining and lower replacement costs. They are used in many forms in the electronics industry, most commonly as substrates upon which the silicon chip is mounted. They will have applications which take advantage of their resistance to wear, corrosion and heat. And they will have specialized applications utilizing their unusual optical, electrical, and magnetic properties.

The excitement about the potential for advanced ceramic applications is so great in Japan that it has been characterized as "ceramic fever." Scientists in Japan prefer to describe the future in this area by saying that we are about to enter the second "stone-age" in the history of man--with these advanced ceramic "stones" opening doors to new technologies.

In only one rather unsophisticated application, ceramic machine tool bits, a study recently completed for NBS ("Technological and Economic Assessment of Advanced Ceramic Materials," Charles River Associates Incorporated, August 1984) indicates a U.S. demand potential of $160 million per year by the year 2000 and an estimated savings in machining costs resulting from substitu-tion of tungsten carbide by ceramics of $533 million in that year. In a much larger application, U.S. commercialization of ceramic engines and the resultant impact on the vehicular industry would realize $279 billion in GNP over the next 20 years and 250,000 additional jobs ("A Structural Ceramic Research Program: A Prelimary Economic Analysis," Argonne National Laboratory, March 1983). It is apparent that we are embarked in an international race to commercialize advanced ceramics, and the prize is well worth an extreme effort.

The major technical barrier impeding competitive commercialization of advanced ceramics is the inability to produce components reliably and reproducibly. In no other materials, save those used in advanced microelectronics, is performance and reliability so sensitive to small microstructural and chemical defects introduced during processing or in use. The interrelationships between these microstructural features and the processing variables are not understood, nor are the relationships between the microstructural features and the resulting in-service performance and durability.

The President's 1986 Budget contains a request in the amount of 3.5 million dollars for NBS to provide the critically-needed measurement methods and standards, key data and predictive concepts required to ensure the reliable performance of advanced ceramics essential for competitive commercialization by U.S. industry. The NBS program will address the technical issues through measurement-based research designed to understand, predict, and control the origin and fate of the performance-limiting features, and to establish those critical linkages between processing variables, microstructure, and materials properties and performance (attachment 3).

The NBS program involves long-range fundamental research of a generic nature that complements and supports associated industrial research efforts. It will be based on existing expertise in experimental and predictive phase diagrams, multicomponent powder synthesis and characterization, high temperature mechanical and durability testing, and models relating performance and failure mechanisms to microstructural properties.

As demonstrated by the history of NBS, these proposed advances in the understanding of advanced ceramics will be carried out in a manner which maximizes the rate of technology transfer to industry. NBS-industrial interactions through research associates and collaborative programs, cooperative research programs with university centers for advanced ceramics, and assignment of key NBS staff on panels and advisory committees are recognized as effective in this crucial step of information transfer.

In closing it is useful to note as reviewed in a recent Washington Post article, (February 10, 1985) that Japan controls 50 percent of the current $4.1 billion market in advanced ceramics. One company alone, Kyocera Ceramics, controls more than 60 percent of the world market for ceramic integrated circuit substrates. Another company, Toshiba targets commercialization of ceramic diesels in the late 1980's and gas turbines in the 1990's. It is not too strong a statement to make that the time for action in this field is now.

Attachment 1

NACE-NBS CORROSION DATA PROGRAM

NBS Battelle Study of Economic Effects of Metallic Corrosion in the U.S. (1978)

Annual Costs = $167B* (4.2% of GNP)

$25B* (15%) Avoidable by Use of Best Current Practices

Improve Data Dissemination System

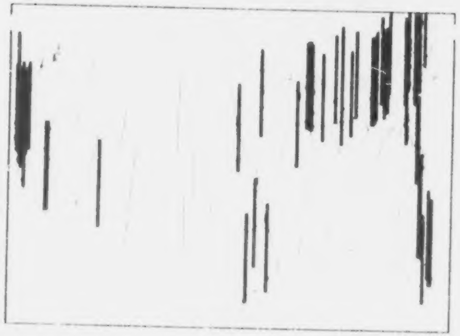
$142B* (85%) Unavoidable with Best Current Practices

Improve Data Base Through Research

Upgrade Corrosion Control Practices Through Evaluation and Improved Application of Available Data

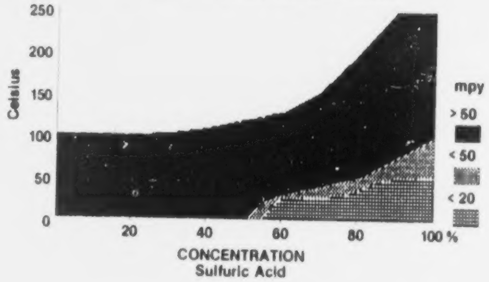
*1985 Dollars

"Metal Test Sites NBS Database"



ATMOSPHERIC CORROSION TEST SITES INCLUDED IN NBS DATABASE ARE SHOWN BY THE LOCATION OF BARS ON THE MAP. CORROSION RATES FOR SPECIFIC ALLOYS CAN BE DISPLAYED AS BARS PROPORTIONAL IN HEIGHT TO THE CORROSION RATE AT THAT SITE.

Isocorrosion Chart for Mild Steel



ISOCORROSION CHART FOR MILD STEEL IN SULFURIC ACID SHOWING REGIONS OF CORROSION RATE OF LESS THAN 20, LESS THAN 50, AND GREATER THAN 50 MILS PER YEAR AS A FUNCTION OF TEMPERATURE AND CONCENTRATION OF SULFURIC ACID IN WATER. (FROM COMPUTER OUTPUT)

NBS COLD NEUTRON RESEARCH FACILITY

BROAD INDUSTRIAL INTEREST

Chemicals

- Dupont
- Exxon
- Eastman Kodak

High Strength Polymer Blends
Catalysts for Chemical Production
Biotechnology

Advanced Materials

- Allied Corp.
- A.T.&T.
- Alcoa

Rapid Solidification Technology
High Technology Magnetic Materials
Superconductors

Computers, Communications

- Intel
- Motorola
- GTE

Semiconductor Technology
Ionic Conductors for Small Batteries

Transportation, Aerospace

- G.E.
- Rockwell International

Turbine Blades for Jet Engines
Advanced Ceramics
Composite Materials

ATTACHMENT 2

ADVANCED CERAMICS: A NEW GENERATION OF HIGH-TECHNOLOGY MATERIALS

UNIQUE PROPERTIES

- Lightweight
- High hardness and strength
- High wear, corrosion and heat resistance
- Specialized optical, electrical and magnetic properties

SOPHISTICATED PROCESSING

- Requires greater control over starting materials, compositions and impurities
- Higher firing temperatures
- Near-net-shape processes
- More of a science than traditional ceramic processing

TECHNICAL BARRIERS

- The propensity of ceramics to *unpredicted,* catastrophic failure
- The inability to produce ceramic components with *consistent, specialized* properties

NBS OBJECTIVE

To provide the scientific base, measurement methods, key data, and predictive concepts that U.S. industries need for the development of reliable advanced ceramics with reproducible and controlled properties.

DR. LYLE H. SCHWARTZ
Director, Center for Materials Science
National Bureau of Standards

Lyle H. Schwartz was appointed Director of the Center for Materials Science in October 1984. He is responsible for NBS' materials science and engineering laboratory, which has more than 350 scientists, engineers, technicians, and support personnel, and an annual budget of approximately $30 million. The major research interests of CMS are metals, polymers, ceramics, and composite materials. CMS is responsible for providing the private sector and government agencies with data, measurement methods, standard reference materials, and new scientific concepts which are fundamental to the development of high performance materials and to advances in materials processing. The programs support wide generic technologies in order to foster the safe, efficient, and economical uses of materials to meet national needs.

Schwartz is a graduate of Northwestern University, Evanston, Illinois, having received his bachelor of science in engineering (1959) and doctorate (1964) in materials science. He began his teaching career at Northwestern as an assistant professor in 1964, became a professor in 1972, then director of the Northwestern University Materials Research Center in 1979.

His experience outside of Northwestern includes undergraduate work (1956-1959) in a student cooperative program at the Argonne National Laboratory, a National Science Foundation postdoctoral fellowship (1963-1964) at the University of Paris, Orsay, and the Centre Energie Nucleaire in Saclay, France, and a visiting scientist post (1971-1973) at Bell Telephone Laboratories. Schwartz has served as a consultant to Argonne National Laboratory and industry.

Schwartz has published more than 70 technical papers in the area of phase transitions in iron alloys, applications of Mossbauer spectroscopy, x-ray and neutron diffraction, characterization of catalysts, and other aspects of materials science. He is a co-author of a textbook on x-ray diffraction.

He serves on a number of technical committees in the materials sciences and is a member of the American Crystallographic Association, American Institute of Mining and Metallurgical Engineering, American Physical Society, American Society for Metals, and the Materials Research Society.

Mr. Brown. Thank you very much, Dr. Schwartz. It's fascinating to hear you describe some of these new developments in materials science. I had never considered that ceramics would be a candidate for machine tool bits, for example, because of their brittleness and other characteristics. How is that problem resolved, or what is the characteristic of these new ceramics that allows them to overcome the problems there?

Dr. Schwartz. The fundamental improvement in the new ceramics is the elimination of defects in the processing stage, and this is the issue that I was alluding to. As we learn more about our ability to form the basic powders from which the ceramics are made and to do that uniformly and reproducibly, we can eliminate the defects and thereby strengthen the final product.

Mr. Brown. Could you give me a brief comparison of the capabilities of the Grenoble facility with the facility that we're planning at NBS?

Dr. Schwartz. My understanding is that in the area of cold neutrons the facility that we're planning will in fact be comparable to that at Grenoble. Of course, it will not come on line for another 4 years, as it is presently planned.

Mr. Brown. Are there any other materials laboratory facilities—and we have a number in the works—that are planning to develop similar or comparable capabilities?

Dr. Schwartz. The only other facility in the United States which has the capability for cold neutron research is the high-flux reactor at Brookhaven. And their proposal was also mentioned in the National Academy study. In the area of cold neutrons, their capability would be considerably limited compared to that at the NBS reactor by virtue of the design of the original reactor. So in terms of cost effectiveness, the NBS situation is rather an unusual one.

Dr. Ambler. May I add to that, Mr. Chairman?

Mr. Brown. Yes, Dr. Ambler.

Dr. Ambler. This facility that we're requesting appropriations for will not be equal to the Grenoble facility but it will be close enough so that our researchers will become competitive.

The recommendation to get on with this came out of a very important report of the National Academy of Sciences, headed by Dr. Seitz, as one of the most important things we could do now. Dr. Schwartz mentioned the possibilities of Brookhaven, but in addition, I believe the Seitz report had as a long-range recommendation that we start planning for something that surpasses Grenoble. But that will be an even longer range thing, and they were unambiguous in saying as an immediate action the construction of this facility was a No. 1 priority.

Mr. Brown. Dr. Johnson, you mentioned this report that you had prepared for the Subcommittee on Science, Technology and Space, and apparently we don't have a copy of that. Do you have a few extra ones lying around that you could provide to the subcommittee?

Mr. Johnson. We will be very happy to supply you with copies for the record, sir.

Mr. Brown. Thank you very much.

[Material to be supplied follows:]

22

PLANNING REPORT

A National Program of Measurement Services and Standards for Biotechnology at the National Bureau of Standards

William H. Kirchhoff

March 1985

Program Office
National Bureau of Standards

A NATIONAL PROGRAM OF MEASUREMENT SERVICES AND STANDARDS FOR BIOTECHNOLOGY AT THE NATIONAL BUREAU OF STANDARDS

Prepared by
William H. Kirchhoff

March 1985

Program Office
National Bureau of Standards

PREFACE

This report is the fifth planning report related to biotechnological research at the National Bureau of Standards. The report was originally written for the Senate Committee on Commerce, Science and Transportation at the request of the Committee. It is being reprinted in the Planning Report series to be used by NBS as a guide for initial program development and for discussions on the needs for measurement-related services to support technological development and economic growth.

ACKNOWLEDGMENTS

Many individuals throughout NBS contributed to this report by providing information, reviewing various drafts, and suggesting corrections, modifications, and additions. Without these contributions, this report could not have been written. The suggestions and advice of Peter Heydemann, Elaine Bunten-Mines and Eugene Domalski were particularly influential on the final structure of the report and are hereby acknowledged with great appreciation.

EXECUTIVE SUMMARY

The economic benefits to the Nation arising from the commercial development of biotechnology have been well documented and are generally accepted. The report, "Commercial Biotechnology," prepared by the Office of Technology Assessment of the U.S. Congress in 1984, identified the inadequacy of government support of generic applied research as a major factor likely to affect the international competitiveness of the U.S. in biotechnology. The NBS program in biotechnology addresses one area of generic applied research - measurement technology.

The commercialization of biotechnology will be measurement intensive, with measurements accounting for as much as 25% of the cost of biotechnology products. Measurements are made at each stage in the development of the products of biotechnology, from the original design of production processes, through the acquisition of raw materials, to the ultimate consumption of products in the marketplace. These measurements are primarily chemical and physical in nature.

Strictly speaking, biotechnology is a technology, not an industry, and the applications of biotechnology range over a diversity of industrial sectors. The measurement requirements for the commercialization of biotechnology, however, are common to all of these sectors. Moreover, the applications of biotechnology, to be successful, will require measurement methods with such sensitivity and selectivity that work must begin now if NBS is to be able to provide the required services when they are most urgently needed.

The goal of the NBS program is to advance the commercialization of biotechnology by providing a measurement system that will be available, useful and reliable. It will do so by

developing physical, chemical, and engineering measurement methods

providing standard reference materials, critical data, and related services.

It will concentrate on a system to:

Measure and predict quantitatively protein structure and function

Separate, detect, and measure accurately biomolecules, their substrates, and products in complex mixtures

Predict, monitor, and control the operating environment of bioreactors including devices for the separation and purification of products.

Initial steps have already been taken after comprehensive planning and consultation with industry. The NBS program is to be national in scope paralleling the measurement standards and services offered by NBS in other areas of technology. It will be conducted in collaboration with other government agencies, industry, and universities in order to take advantage of the biological expertise existing in those organizations and to extend the effectiveness of its technology transfer activities.

TABLE OF CONTENTS

PREFACE i

ACKNOWLEDGMENTS ii

EXECUTIVE SUMMARY iii

I. INTRODUCTION

A. The economic benefits to the Nation arising from the commercial development of biotechnology have been well documented and are generally accepted. 1

B. The removal of technical barriers to the commercialization of biotechnology will require a reliable measurement system 2

C. The services offered by NBS in biotechnology will be based on the traditional NBS strengths in physical and chemical measurements. 2

D. The structure of the report 3

II. THE ROLE OF MEASUREMENT IN THE COMMERCIAL DEVELOPMENT OF BIOTECHNOLOGY

A. Definition of Biotechnology 4

B. The commercialization of biotechnology will be measurement intensive. 4

C. The measurements made in biotechnology will be primarily chemical and physical in nature. 7

D. The product-specific measurement methods which will eventually form the components of a measurement system for biotechnology will be developed mostly by others. NBS research and services will assure the adequacy, compatibility and quality of that system. 8

E. Although the applications of biotechnology range over a diversity of industrial sectors, the measurement requirements for the commercialization of biotechnology are common to all of these sectors. 10

F. The measurement system for biotechnology will be complex and work must begin now if NBS is to be prepared to provide the required services in a timely manner. 13

III. THE PROCESS TO DEVELOP THE NATIONAL PROGRAM OF MEASUREMENT SERVICES AND STANDARDS FOR BIOTECHNOLOGY AT THE NATIONAL BUREAU OF STANDARDS 15

IV. THE NBS PROGRAM IN BIOTECHNOLOGY

Program goal 18

A. Measurement and prediction of protein structure and function. 18

B. Separation, detection, and quantification of biomolecules in complex mixtures. 20

C. Bioprocess monitoring and separation and purification of products. 22

V. RELATIONSHIP TO THE PROGRAMS OF OTHER INSTITUTIONS

A. OTHER GOVERNMENT AGENCIES 24

Department of Agriculture 25
Department of Defense 25
Department of Energy 26
Environmental Protection Agency 26
Food and Drug Administration 26
National Institutes of Health 27
National Science Foundation 27

B. INDUSTRY 28

C. UNIVERSITIES 30

D. CENTER FOR ADVANCED RESEARCH IN BIOTECHNOLOGY 30

A National Program of Measurement Services and Standards for Biotechnology at the National Bureau of Standards

I. INTRODUCTION

The Committee on Commerce, Science and Transportation of the U.S. Senate, in its report on the authorization of appropriations to the Secretary of Commerce for the programs of the National Bureau of Standards (NBS) for fiscal year 1985, directed NBS to prepare by the end of calendar year 1984 a plan on a national effort in measurements and standards for biotechnology. This report fulfills that direction.

A. The economic benefits to the Nation arising from the commercial development of biotechnology have been well documented and are generally accepted.

Recent advances in molecular biology have led industry and government worldwide to recognize the economic potential for applying these advances in a diversity of industrial sectors. These include the production of new drugs, food additives and chemicals; the degradation of toxic wastes; the extraction of metals from ores; the improvement of agricultural products and medical diagnostic measurements; and the development of instrumentation for product and process monitoring. Various estimates of the size of the worldwide market for biotechnology-derived products range from a low of $9 billion to over $50 billion by the year 2000. The economic and technical issues surrounding the commercial development of biotechnology have been extensively reviewed in two recent publications: "Biotechnology, International Trends and Perspectives," published by the Organization for Economic Cooperation and Development in 1982 (hereinafter referred to as the OECD Report) and "Commercial Biotechnology, An International Analysis," published by the Office of Technology Assessment of the U.S. Congress in 1984 (hereinafter referred to as the OTA Report.) The conclusions of the OTA report form the basis for the present analysis and the impetus for the NBS plan. In particular:

> "The United States could have difficulty maintaining its competitive position in the future if several issues are not addressed.... U.S. Government funding of generic applied research, especially in the areas of bioprocess engineering and applied microbiology, is currently insufficient to support rapid commercialization.... Of the competitor countries, the United States, both in absolute dollar amounts and in relative terms, has the largest commitment to basic research in biological sciences.... On the other hand, the U.S. Government's commitment to generic applied research in biotechnology is relatively small. The

governments of Japan, the Federal Republic of Germany, and the United Kingdom fund a significant amount of generic applied science in biotechnology."

This report focuses on one aspect of what the OTA report refers to as "generic applied research", namely measurement science and describes its importance to the commercial development of biotechnology. It then outlines a research and development program at NBS designed to meet national measurement needs.

B. The removal of technical barriers to the commercialization of biotechnology will require a reliable measurement system.

Both the OTA and OECD reports cite significant technical problems which must be overcome in order for the economic potential of biotechnology to be fully realized. Many of these problems require for their solution a measurement capability unprecedented in its demands for sensitivity and selectivity. These measurement problems extend from the most basic scientific measurements to the requirements of the marketplace for uniformity and equity. Their resolution will range from extensions of current chemical measurements to measurements of properties that were unknown a few decades ago.

C. The services offered by NBS in biotechnology will be based on the traditional NBS strengths in physical and chemical measurement.

NBS recognizes that the commercial development of biotechnology will require an advanced system of physical and chemical measurements. To meet these new measurement requirements, NBS will draw upon its physical, chemical, and engineering strengths, while capitalizing on the expertise of others in biology or microbiology. The goal of the NBS program is to assure that the measurement system required for the commercialization of biotechnology will be available, useful, and reliable. In meeting this goal, NBS will

develop physical, chemical, and engineering measurement methods and mathematical models and

provide standard reference materials, critical data, and related services.

The NBS program will be national in scope, paralleling the measurement standards and services offered by NBS in other areas of technology. NBS will cooperate with industry, other government agencies, and universities in order to avoid duplication of effort, to assure that the services offered by NBS address the most critical measurement problems, and to ensure an effective means of technology transfer.

D. The Structure of the Report.

This report describes the role of measurement in the commercialization of biotechnology, the chemical and physical nature of measurements as they apply to biotechnology, the NBS process to develop a plan for a national program of measurement services and standards for biotechnology, the technical goals and objectives of the program, and the relationship of the NBS program to those of other institutions and organizations.

II. THE ROLE OF MEASUREMENT IN THE COMMERCIAL DEVELOPMENT OF BIOTECHNOLOGY

A. Definition of Biotechnology

The term biotechnology as used by NBS in the description of its programs is:

> The application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services.

This is the definition adopted in the OECD Report. The OTA definition includes the development of micro-organisms for specific uses and the improvement of plants or animals. These aspects of the OTA definition are not relevant to the NBS program. The OTA definition also differentiated between biotechnology using novel techniques and the more traditional forms of biotechnology, describing the two as the "new" and the "old" biotechnologies respectively. Insofar as the "new" and "old" biotechnologies share common measurement requirements, both would fall within the NBS program.

Biotechnology is, strictly speaking, a technology, not an industry. The applications of biotechnology range over a diversity of industrial sectors and a diversity of firms, from small research and service laboratories to large corporations. Reference to the biotechnology industry in this report is a reference to all industrial sectors with biotechnology applications.

B. The commercialization of biotechnology will be measurement intensive.

Measurements must be made at each stage in the development of any product, from the original design of the manufacturing process through the acquisition of raw materials to the ultimate consumption of the product in the marketplace. The products of biotechnology are no exception.

During research and development:

> New enzymes having desired properties are identified, isolated, and tested
>
> Enzymatic action is characterized as a function of measured process variables and conditions
>
> Reaction products and byproducts are characterized
>
> Methods for separating and purifying products are evaluated using reference data on the properties of the separating media and data obtained from the performance of pilot scale operations

Processes are optimized for energy and raw material efficiency using data on the thermodynamic properties of reactants and products

For food additives, drugs, and products introduced into the environment, the safety and efficacy of end use is demonstrated.

During production:

The identity, purity, integrity, and stability of raw materials - enzymes, substrates (the chemicals upon which the enzymes act), nutrients, and micro-organisms - are measured

The operating environment is monitored for temperature and pressure, fluid properties, the concentration of oxygen and carbon dioxide, pH, and the concentration of cells, nutrients, substrates, inhibitors, products, and diagnostic intermediates in order to maximize the operating efficiency of bioreactors and to assure the quality of their products.

During post-production transactions:

The purity and stability of products are verified using test methods that are agreed upon by both buyers and sellers

Compliance with regulations for environmental safety and the protection of workers is demonstrated using test methods that are agreed upon by the regulators and the regulated.

The OTA report identifies technical problems which need to be overcome in order for the U.S. to realize the economic benefit from its investment in biotechnology-related research. Some of these problems are identified explicitly as measurement needs. For example, the report recommends increased research to meet the needs of manufacturers for a wide range of sterilizable sensors for process monitoring and control and the needs of process design engineers for screening techniques to identify biological processes useful for the production of desired products. However, many more of the report`s recommendations either imply a measurement requirement or assume an adequate measurement base for their resolution which may not be currently available:

OTA RECOMMENDATION	MEASUREMENT BASE REQUIRED
Improved product recovery techniques	Measurement methods for evaluating and comparing product recovery
Computer aided design of enzymes with specific catalytic activity	Methods for measuring the structures of enzymes as well as methods for monitoring catalytic activity in order to verify the accuracy of computer design techniques

Maintenance of biocatalytic stability	Methods for monitoring biocatalytic stability and for identifying the causes of instability
Understanding the thermal stability of proteins	Methods for monitoring stability and for identifying molecular structural factors responsible for instability
Understanding the structure and function of the cellulase and ligninolytic activities of microorganisms	Measurement methods to relate the structure and function of enzymes
Application of analytical measurement methods such as electrophoresis and high performance liquid chromatography to production scale separation technology	Knowledge of the physical and chemical principles of these analytical measurement methods as they pertain to biomolecules in order that they might be more fully exploited.

The OECD Report describes a nearly-identical set of problems requiring further research. In addition it suggests that "bioinformatics" (the interface between information technology and biology) is an important area requiring research attention. From the perspective of the NBS role in the commercialization of biotechnology, however, the question of data accuracy is just as important as the management and retrieval of complex systems of inter-related data. The interpretation and use of data are profoundly influenced by the accuracy and perceived reliability of data, and yet the assurance of data accuracy is frequently ignored in the early stages of the development of a new technology. For example, neither OTA nor OECD explicitly addresses data accuracy.

In a recent study conducted by NBS of the cost of measurement in 20 major sectors of the U.S. economy, the average value added from measurement-related activities was estimated to be 3.5%. This estimate was derived from industry estimates of labor costs for the sectors studied. For the Chemicals and Selected Chemical Products sector, which should give the closest analogy to the biotechnology industry, the average cost of measurement labor, as a percentage of total labor (the surrogate measure of value added by measurement), was estimated to be 12.5%, representing a range from 1.0% to 24.0%. Those industry subsectors having low estimates of measurement cost were those for which measurement consisted primarily of weighing basic chemicals for combining and compounding purposes. These estimates of measurement's contribution to value added are conservative in that the study did not count costs associated with the monitoring of measuring instruments in its estimates. The study also did not include an analysis of the economic consequences of inaccurate measurement. The overall study did note that industries characterized by more advanced technology are more measurement-intensive. Application of these study results to the more complex bioprocessing industries would indicate th as much as 25% of the value added by biotechnological production processes could be attributed to measurement activities.

C. The measurements made in biotechnology will be primarily chemical and physical in nature.

The rapid growth of interest and activity in biotechnology within the last ten years has been a direct result of the ability of scientists to manipulate the chemistry of living organisms at a molecular level. Measurement techniques that were developed originally for simple chemical systems contributed significantly to this progress through successful application to the large, complex molecules characteristic of biological systems. For example, X-ray diffraction techniques were used in the early 1950's to determine the structure of DNA with sufficient resolution to allow understanding of the nature of genetic coding. The successful application of electrophoresis to the analysis of mixtures of DNA fragments has allowed the sequencing of genes to be determined rapidly and has opened the way for the design of new bioprocesses - the major feature of what the OTA report calls the "new biotechnology". The measurement methods which will be used in the commercialization of biotechnology will likewise be based on chemical and physical principles. The measurement requirements, however, are unparalleled in their demands for sensitivity and specificity.

In analyzing measurement methodology required for the commercial development of biotechnology (Section III of this report), NBS has identified six general classes of measurement and data needs that are common to nearly all industrial sectors. These are:

Detection and identification of biomolecules, principally proteins and nucleic acids
Quantitative relationship of protein structure and function
Quantification of substrates and products
Thermodynamic properties of substrates and products
Characterization of separation techniques
Characterization of the operating environment of bioreactors

Methods which show the greatest promise for acquiring this information include:

X-ray and neutron diffraction
Nuclear Magnetic Resonance Spectroscopy
Microscopic imaging techniques
Electrophoresis
High Performance Liquid Chromatography
Calorimetry
Molecular Spectroscopy

These are all measurement techniques which have been developed for simpler chemical systems and which have been applied with some success to the complex chemical systems characteristic of biotechnology. In addition, Major developments can be expected in the new areas of biosensors and the use of biomolecules for quantitative analysis of the components of complex chemical systems.

D. The product-specific measurement methods which will eventually form the components of a measurement system for biotechnology will be developed mostly by others. NBS research and services will assure the adequacy, compatibility and quality of that system.

Although chemical and physical measurements have allowed research scientists to make rapid progress in biological manipulation and control, the methods themselves have required highly skilled practitioners, many of whom have dedicated their careers to measuring select classes of biomolecules with single instruments of unique design. Instruments and methods which have served as valuable research tools to date have not been designed for routine monitoring and consequently cannot be used for most commercial purposes. For example, X-ray crystallography, which has provided structures of pure proteins, would be unacceptable as a method for assaying commercial enzymes. The commercialization of biotechnology will require a system of more accessible and compatible measurement methods, useable by individuals of varying skill, and capable of providing verifiable data. Such a system will not necessarily evolve as measurement methodology is developed. This is because:

Measurement methods are developed by individuals to suit their own purposes and are not validated for circumstances beyond those purposes. Compatibility with other measurement methods is generally not a high priority in their development. For example, a chromatographic method developed for the analysis of the components characteristic of a particular process may give misleading results when used without modification or verification for the analysis of some of the same components in a mixture characteristic of another process.

Measurement methods are limited by existing instrumentation. For example, the electrophoretic determination of the purity of a particular enzyme sample may be deemed an adequate method merely because it provides the best separation achievable. It may not be adequate however to detect the presence of other proteins which separate with the first enzyme and which may be either essential to the action of the enzyme or in some way inhibit its action. The method itself, however, will give no evidence that a better measurement method is required.

Established methods of measurement, when put into practice, can be subtly altered by their practitioners to suit the circumstances of the moment with unpredictable consequences for the accuracy of the resulting data. The environment of a system under analysis, the temperature, the full composition of the media, the purity of reagents and probes, can alter the results of measurement and yet give no clue that alterations have occurred. Established methods must be validated for new circumstances. The only sure basis for validation is the demonstrated accuracy of measurement. Such a demonstration is often beyond the capabilities and resources of those who wish to use existing methodology for new applications.

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A collection of measurement methods will not be a system until the individual measurements are compatible, that is, until they depend on a common basis.

Compatibility of measurements is necessary not only to allow buyer and seller or regulator and regulated to communicate in a common language of quantitative measurement. It also increases the efficiency with which processes can progress from the laboratory to industrial production. If the measurement methods used in the evaluation of a laboratory-scale process are not compatible with the monitoring measurements available for an industrial scale process, the development of the latter will inevitably be slowed.

Industry alone cannot provide the common basis for a measurement system in biotechnology. There is no way for individual firms to recapture an investment in the development of a common basis for all applications of biotechnology. This lack of investment return is exacerbated by the fact that the applications of biotechnology range over a diversity of independent industrial sectors. Moreover, the new biotechnology firms that are providing the U.S. with a commercial edge in the current research-intensive phase of biotechnology's development have a biological perspective and are focused (as they should be) on developing new processes for new products. The OTA report recognized the fragmented nature of the industrial applications of biotechnology and stated that

> "Developing an effective infrastructure to support the commercialization of biotechnology, therefore, may be more complex than was developing an infrastructure to support the semiconductor industry."

An adequate measurement system is the core of an effective infrastructure.

The National Bureau of Standards was created with the mission of maintaining the integrity of the national measurement system by providing standards of measurement and the means for assuring compatibility of measurements with those standards. To this end, NBS develops:

definitive, reference measurement methods capable of providing data of known accuracy in terms of internationally accepted units of measurement.

standard reference materials certified using these measurement methods.

reference data with supporting mathematical models evaluated in terms of these measurement methods.

Standard reference materials (SRM's) from NBS will be needed by industry and science to resolve differences among different methods and to provide a mechanism for relating data acquired with one method to those acquired by another. This will reduce the uncertainty and risk in exploiting laboratory research in biotechnologies and in market transactions. SRM's will be needed to support quality control which will increase productivity, reduce costs, and improve the competitive position of U.S. industry in the world market.

Reference data will be used by scientists and engineers to optimize biotechnology production design, which will also reduce the costs associated with production and improve the competitive position of U.S. industry.

The development of the measurement system in biotechnology will not be accomplished by NBS alone. NBS will work with industry, other government agencies, and with appropriate U.S. voluntary standards organizations where reference measurement methodology is evaluated through the consensus process (Section V.B of this report). Currently, voluntary standards related to biotechnology are being developed by the National Committee for Clinical Laboratory Standards (NCCLS) in which NBS holds a membership and its staff serve as officers. The American Society for Testing and Materials (ASTM) has, for the past four years, been reviewing standards needs in biotechnology and is currently considering initiating a standards-writing committee in this area. NBS scientists are participating in the ASTM review.

E. Although the applications of biotechnology range over a diversity of industrial sectors, the measurement requirements for the commercialization of biotechnology are common to all of these sectors.

NBS has identified six general classes of measurement requirements which are common to almost all applications of biotechnology. In the following paragraphs, examples are given to illustrate this commonality.

1. Detection and identification of biomolecules, principally proteins and nucleic acids.

The common feature of almost all of the applications of biotechnology is the use of proteins as biocatalysts or chemical reagents, either directly or through intact cells. In a recent National Academy of Engineering symposium on "Cutting Edge Technologies", Dr. Charles R. Cooney, Professor of Chemical and Biochemical Engineering at MIT, noted that in regard to the use of biotechnology for the production of commodity and speciality chemicals, "It is really the biocatalyst and its exquisite selectivity on which the potential of the biotechnical process industry is based." In describing the applications of biotechnology to the health care industry, Dr. J. Paul Burnett, Director of Molecular and Cell Biology Research at Eli Lilly & Co., Inc., stated that "Proteins are the molecules in the cell that give rise to all of the characteristics that are recognized for particular cells." Two individuals, one from industry and one from a university, emphasizing two rather different applications of biotechnology - but both identified proteins and their function as the key for the application of biotechnology. In order to realize the full potential of biotechnology, scientists must be able to detect and identify proteins in complex mixtures.

2. Quantitative relationship of protein structure and function.

The design of new processes or the optimization of existing processes will depend on the ability of scientists to alter the structure of proteins and hence the function of those proteins. This will be possible only if the structures of proteins can be measured easily and reliably and if the effects on function of changes in structure can be predicted. This requirement transcends the area of industrial application. For example, the OTA report lists as one of the research priorities for the pharmaceutical industry the "clarification of the functions and mechanisms of action of immune regulators such as interferon and interleukin-2." The OTA report also notes that recombinant DNA techniques can improve the operating characteristics of enzymes to produce economical yields of specialty chemicals and food additives. In both of these applications, scientists will need measurement methods to determine the structures of proteins and they will need reference data with accompanying mathematical models to assess the effect of modifications in protein structure on function.

3. Quantification of substrates and products

Substrates are the chemical compounds upon which proteins act to give the products of the enzymatic catalysis. A major advantage of the commercial use of bioprocesses is the specificity with which they can produce chemically complex products. A characteristic of microbial catalysis is the complexity of the reaction broth which contains intact cells or enzymes, substrates, nutrients, products, and byproducts of other metabolic reactions. Measurement methods are needed to identify and quantify substrates and products in order to assure the quality of raw materials, to assess the efficiency of the bioprocess under investigation, to monitor the performance of bioreactors, and to demonstrate the quality of products. Measurement methods such as electrophoresis, chromatography, and mass spectroscopy are applicable to broad classes of chemical compounds regardless of the processes which consume or produce them. The measurement requirements derive from the extraordinary complexity of reaction broths and the specificity with which similar substances need to be distinguished.

4. Thermodynamic properties of substrates and products

Enzymes are catalysts. They speed up chemical reactions but do not alter the thermodynamic equilibrium between substrate and products. Therefore, from measurements of the thermodynamic properties of substrates and products, scientists and engineers can determine whether a particular biocatalytic process is possible. They can determine whether more product will be produced at higher temperatures and therefore whether a search for enzymes tolerant of higher temperatures would be profitable. Moreover, if data of known accuracy were provided for representative compounds, estimates of the properties of new compounds could be determined with sufficient accuracy to allow the estimates to be used directly without further measurements or to assess the reliability of new measurements. The challenge of biotechnology is in the measurement of the small effects of subtle structural changes occurring in the dilute aqueous environments characteristic of bioprocesses. The measurement challenges are the same whether the process under consideration is one which will produce amino acids for use as food additives or whether it will be one for the biological extraction of metals from ores.

5. Development and characterization of separation techniques

Every study of the potential benefits of biotechnology has identified the problem of separating desired products from complex reaction broths as a major barrier to the economic exploitation of biotechnology. The OTA report states, "Separation and purification techniques used in bioprocesses are the aspect of bioprocess engineering most in need of attention, especially for the production of novel products such as proteins." Separation and purification techniques depend on general properties of the medium and the separating means. For example, membranes can be used to separate classes of compounds from a complex mixture by allowing transport across the membrane only for compounds with certain combinations of properties. The measurement problem is one of relating the degree of separation to the structure of the membrane and size, chemical, and electrical properties of the constituent chemicals of the medium. Insofar as all microbiological processes occur in a water environment containing a multitude of chemical compounds, the need for separation techniques is common to all applications of biotechnology.

6. Characterization of the operating environment of bioreactors

The operating environment of bioreactors is a heterogeneous and fragile broth of cells, biomolecules, nutrients, and products. Cells and large molecules can be destroyed by too rapid mixing. Processes of interest may take place within very limited ranges of environmental variables and are often characterized by a multiplicity of pathways, such as the transition between the growth phase for intact cells and the production phase. The reaction environment must remain free of contaminating organisms. The balance between nutrients, inhibitors, reactants, and products must be maintained uniformly throughout the reacting medium for optimum production. Process control will require the coupling of process monitoring with computer-based process models. The OTA report notes that, "Despite the need for close control of process variables during a bioprocess operation, the techniques available for making measurements on-line are extremely limited." and "The automation of bioprocessing will be of critical importance in the future as companies compete for shares in biotechnology product markets." The commonality of required measurement methodology and process models reflects the common conditions of bioprocessing.

In summary, the commonality of the measurement requirements in biotechnology is a direct reflection of the common features of all biological systems. All biological molecules are built from a finite number of simple molecules and molecular fragments. Methods of chemical analysis and thermodynamic data for such molecules and their components, their interactions with each other, and their interactions with solvents and surfaces can be used for engineering design and optimization. Because the component molecules and molecular fragments are, for the most part, known, NBS can begin providing measurement methods and useful, evaluated data now. Because their number is finite, the problem of providing comprehensive data and measurement standards, though difficult, is manageable. Because they are universal, reference materials and data will be useful for nearly any process imaginable at this time.

F. The measurement system for biotechnology will be complex and work must begin now if NBS is to be prepared to provide the required services in a timely manner.

The NBS mission is to develop national standards of measurement for use in scientific research, engineering, manufacturing, and commerce. In accomplishing this mission, NBS is authorized to

- Develop, maintain, and disseminate standards for physical and chemical measurements
- Determine the properties of physical materials
- Develop test methods for materials, mechanisms, and structures
- Establish standard practices in cooperation with other government agencies and the private sector.

The measurement needs described in the preceding sections of this report and the measurement services described in Section IV are clearly within the mission of NBS. In addressing the measurement needs for the commercialization of biotechnology, NBS will be addressing measurement problems of unprecedented complexity requiring methods of unprecedented sensitivity and selectivity. Consequently, this plan stresses the measurement capability NBS must develop in order to be able to provide required services as biotechnology matures. Some reference materials and reference data, particularly for simple substrates and products, can be provided now, but most cannot.

A measurement system does not yet exist for biotechnology. Methods have been developed by scientists from a diversity of backgrounds and frequently share no basis for intercomparison nor possess a basis for quantitative measurement. This diversity of backgrounds hinders the collaboration of scientists in the development of a measurement system. NBS plans to take a leadership role, working with industry, the voluntary standards system, universities and other government agencies to build the collaboration necessary to assemble a reliable measurement system. Development of the measurement base and the voluntary standards process must begin now in order to be responsive to the commercialization of biotechnology.

If NBS waits until the extent and nature of the applications of biotechnology are fully shaped, then critical measurement services will not be available when most urgently needed. If the U.S. is to be competitive in biotechnology, NBS needs to be equipped to provide measurement services at those times when U.S. firms are bringing new products to market. Otherwise, market penetration will be slowed and competitive advantage lost.

III. THE PROCESS TO DEVELOP THE NATIONAL PROGRAM OF MEASUREMENT SERVICES AND STANDARDS FOR BIOTECHNOLOGY AT THE NATIONAL BUREAU OF STANDARDS

Planning for a national program of measurement services and standards for biotechnology at the National Bureau of Standards has been underway since 1979. Four planning reports have been issued:

Bunten-Mines, E., Planning Report 1: "NBS Contributions to Biotechnology: A Preliminary Report." National Bureau of Standards, Department of Commerce, April 21, 1980.

Coates, J. F., Planning Report 9: "Implications of Biotechnology for the National Bureau of Standards. A Seminar Presentation." National Bureau of Standards, Department of Commerce, November 16, 1981.

O'Brien, T. C., Planning Report 12: "NBS and Industrial Biotechnology: Technical Developments and Future Measurement Needs." National Bureau of Standards, Department of Commerce, July 1982.

O'Brien, T. C., Planning Report 14: "NBS and Industrial Biotechnology: Instrumentation and Associated Measurement Needs." National Bureau of Standards, Department of Commerce, March 1983.

The conduct of these studies involved, in addition to a review of existing literature on the subject, extensive interviews with experts in policy as well as scientific issues from other government agencies, industries, and universities. They included individuals from large chemical firms (Monsanto, Dow, Corning Glass Works, CPC International), smaller research and development firms (Genex, Bethesda Research Laboratories), trade, professional, and service associations (Industrial Biotechnology Association, American Society for Microbiology, American Type Culture Collection), investment consultants, NSF, MIT, and the USDA. NBS management and technical staff participated fully in all of the interviews and in the review of the reports.

These reports contain summaries of the major technical problems inherent in the commercialization of biotechnology and they identify existing NBS expertise which could be brought to bear on the solution of these problems. These reports, along with the discussions described below between NBS scientists and managers and representatives of other organizations, led to the identification of the six areas of measurement needs described in Sections II.B and II.E of this report and to the technical plan outlined in Section IV. These reports were also used by the Office of Technology Assessment to prepare its report on the commercialization of biotechnology.

Beginning in 1981, a biotechnology seminar series was initiated by the NBS Centers for Analytical Chemistry, Chemical Engineering, and Chemical Physics. These seminars provided the NBS scientific staff with reviews of measurement problems in biotechnology. Moreover the outside speakers participated in extensive discussions with NBS scientists and managers on details of possible NBS efforts in biotechnology. Over 50 of these seminars were held in 1983 and 1984 representing:

Industry:

Advanced Mineral Technologies, Inc.
Dupont
Hewlett-Packard
LKB Instruments
W. R. Grace & Company
Corning Glass Works
Genex
Industrial Biotechnology Assoc.
Miles Laboratories

Federal Agencies:

Department of Agriculture
National Institutes of Health
St. Elizabeth's Hospital
Food and Drug Administration
Office of Technology Assessment
U.S. Army R. & D. Laboratories

Academic Institutions:

University of Arizona
Cold Spring Harbor Laboratory
Cornell University
Johns Hopkins University
University of Maryland
University of Michigan
Purdue University
University of Rhode Island
Virginia Commonwealth University
University of Washington
University of California, Berkeley
University of Colorado
Iowa State University
Lehigh University
Massachusetts Inst. of Technology
Pennsylvania State University
Rensselaer Polytechnic Inst.
Medical University of South Carolina
University of Virginia
Yale University

In addition, several speakers from other countries presented seminars at NBS related to biotechnology. Also, in collaboration with other organizations, NBS sponsored two workshops dealing with standards needs related to biotechnology. The first of these dealt with electrophoresis, a common measurement method for biomolecules. Cosponsored by the Electrophoresis Society of the Americas, the workshop attracted 54 attendees from a variety of organizations including 15 industrial representatives and 8 universities. The second workshop dealt with standards needs associated with biomass conversion. It too attracted representatives from a variety of organizations and was cosponsored by the Department of Energy.

As part of the NBS program in "competence development", NBS began to develop its own scientific capabilities in measurement methods which could be applied to the complex chemical systems characteristic of biotechnology. Two competence tasks were initiated in 1982. The first was in condensed phase chemistry with the objective of developing measurement methods and predictive mathematical models for describing the properties of biochemical compounds in solution. The second was in bioanalytical chemistry with the objectives of developing methods of protein analysis and new methods of chemical analysis based on the unique chemical properties of certain classes of proteins. As a result, collaborative interactions have been initiated between NBS scientists and scientists from Corn Products, Nabisco Brands, Inc., IBM, the National Oceanic and Atmospheric Administration, the U.S. Department of Agriculture, the Department of Energy, and the Max Planck Institute for Experimental Medicine in Göttingen, Germany.

NBS plans in biotechnology have been discussed with the NBS statutory Visiting Committee, the NAS\NRC Boards of Assessment of the Centers for Analytical Chemistry, Chemical Physics, Chemical Engineering, and Materials Science. These include key representatives and top experts from universities and industry. The plans have also been discussed with a panel of the National Research Council on Chemical Processing Engineering for Biotechnology, with officials of the Department of Commerce, the National Science Foundation, the National Research Council, the President's Office of Science and Technology Policy, and with staff of the NBS authorization committees of both the U.S. Senate and the U.S. House of Representatives.

This report is the result of all of the deliberations and discussions to date. Planning will continue at all levels well after the program has been initiated. NBS management will continue to discuss NBS plans with their counterparts in other organizations to ensure that the broad objectives of the program remain responsive to the needs of industry, government, and the scientific community in general. Workshops will continue to be a basis for addressing scientific issues in broad measurement areas related to biotechnology. Members of the scientific staff of NBS, through direct collaboration and through professional interactions, will continue to assess the technical directions of their portions of the program and adjust their efforts accordingly.

IV. THE NBS PROGRAM IN BIOTECHNOLOGY

The goal of the NBS program is to advance the commercialization of biotechnology by providing the measurement methods, the standard reference materials, and the reference data needed by industry, other government agencies, and the scientific community in general to:

Measure and predict quantitatively protein structure and function.

Separate, detect, and measure accurately biomolecules, their substrates, and products in complex mixtures.

Predict, monitor, and control the operating environment of bioreactors including devices for the separation and purification of products.

The three parts of the overall goal reflect the six measurement requirements described in Sections II.C and II.E of this report and are related directly to the missions of the NBS Centers for Chemical Physics, Analytical Chemistry, Chemical Engineering, and Materials Science - where most of the technical work for the biotechnology program will be conducted. In order to achieve its goal, NBS will initiate the program by developing measurement methods which NBS needs in order to provide the required reference materials and data. Thus, for each of the three parts of the NBS program goal, near-term measurement objectives have been defined. These objectives are described in the following three sections.

A. Measurement and Prediction of Protein Structure and Function.

Why this is important:

The realization of the economic benefits to be derived from the commercialization of biotechnology depends at the most fundamental level on the ability of scientists to direct the processes of living organisms to produce chemicals with desired properties. New techniques in genetic manipulation have allowed scientists, for the first time, to alter the genetic information in living organisms in a deliberate, methodical fashion. The techniques of genetic manipulation are of limited usefulness, however, without quantitative knowledge about the products of genetic expression - namely proteins. Proteins are the molecules in the cell that give rise to all of the cell's recognizable characteristics, and it is the extraordinary selectivity and specificity of protein function that gives biotechnology its commercial attractiveness. In order to modify the functions of living organisms, the function of their proteins must be modified. The protein function is a direct result of its structure and, indeed, it is the structure which is modified through modification of the genetic code. Without knowledge of the relationship of protein structure to function, new processes can be developed only through trial and error, assisted by inspired and intelligent intuition.

What NBS will provide:

- Improved methods of measurement for the determination of protein structure and for determining the effects upon that structure of the protein environment.
- Reference data and models for predicting the effects of environmental variables such as pH and temperature on protein function.
- Reference data and models for relating protein structure to function.

Mathematical models are the complement of reference data. They can be simple equations which relate one property to another (as in the ideal gas law or the laws of thermodynamics) or they can be complex computer codes for estimating properties of molecules from fundamental theories of matter. Mathematical models allow for the extrapolation, interpretation, and prediction of properties and for testing the internal consistency of a body of data. The use of mathematical models can save time and expense in the valuation of untried processes. Reference data allow for the testing of the accuracy of the mathematical models. Reference data without mathematical models and mathematical models without reference data are of limited usefulness.

The usefulness of mathematical models to predict the properties of biomolecules is enhanced by the simplicity of the chemical composition of those molecules. The entire genetic information of all living organisms is stored in the sequence of only four nucleotide molecules assembled into enormous strands of DNA. Although a single cell may contain thousands of different proteins, each with a unique function, all of these proteins consist, for the most part, of only twenty amino acids. The sequence of nucleotides in a cell's DNA determines the sequence of amino acids in all of the cell's proteins. This underlying molecular simplicity promises an ability to predict the structure and function of biomolecules with sufficient accuracy to reduce greatly the amount of experimental time necessary to characterize a new or unknown biological process.

Program Objectives:

Couple the techniques of x-ray and neutron diffraction to give improved structures of protein molecules, including bound water.

Combine the techniques of pulse-driven, polarization transfer and two-dimensional NMR to allow analysis of selected molecular fragments of large biomolecules. Develop computational methods for the analysis of two-dimensional NMR measurements.

Couple calorimetric measurements of the energy released or absorbed during enzymatic catalysis with chromatographic and spectroscopic measurements of substrate, proteins, and products in order to identify molecular pathways for catalytic processes and to identify the conditions for protein stability.

Develop mathematical methods for the calculation of energy surfaces and structural details of biomolecules and their interactions with metals for use in predicting the catalytic action of enzymes and for relating enzyme catalysis and structure.

Develop methods for characterizing the effects of immobilization of enzymes and antibodies on the function of these proteins.

Provide tables of thermodynamic properties of enzyme substrates and products. Provide tables of the thermodynamic properties of component molecules and molecular fragments of biomolecules, including interactions among them and interactions with solvents.

B. Separation, Detection, and Quantification of Biomolecules in Complex Mixtures.

Why this is important:

The chemical analysis of biological systems is important in every phase of a biotechnological process. The characterization of a potentially useful process will depend on accurate measurements of product yields as a function of the process environment. Raw materials, enzymes and their substrates, must be assessed for their purity prior to their use. Process design will require accurate measurements of product yield as a function of operation variables such as pH, temperature, nutrient concentrations, and dissolved gases. Quality control of products will require accurate measurement of product purity. Sale of product will rely upon demonstrated product characteristics. Each of these measurements consists of the detection, identification and quantification of simple as well as complex molecules in complex mixtures.

Without accurate measurements, potentially useful and profitable processes could be erroneously rejected, product testing could be needlessly repeated, processes could be needlessly interrupted, and products and raw materials improperly represented. These are measurement concerns for most industries. The complexity of biotechnology, however, makes its measurement requirements more acute.

What NBS will provide:

- Evaluation of the accuracy and reliability of measurement methods.
- Standard Reference Materials and research materials.
- New and improved methods of chemical analysis.

Measurement methods used in transactions require not only a basis in accuracy, but also acceptance by the parties engaged in the transaction. Reference methods are adopted by voluntary standards bodies to meet both of these objectives. Generally, the latter requirement, the requirement of mutual acceptance, is assured by the consensus process of voluntary standards development. The former requirement can be achieved only through painstaking study of the relationship of the measurement process to the fundamental constants and laws of physics and chemistry. Moreover, methods performance must be demonstrated by "typical" analysts in collaborative studies using well characterized materials. To make it possible to evaluate the accuracy and reliability of measurement methods, NBS will conduct thorough examinations of key measurement techniques, identifying and eliminating where possible major sources of measurement variability. NBS will also conduct, in collaboration with other organizations, studies of reference methodology.

The continuing reliability of a measurement system can be assured only through periodic demonstrations using accepted and accurately characterized reference materials. NBS is recognized around the world as a principal source of such materials.

Program Objectives:

Characterize the origins and causes and minimize the effects of analytical variability in the use of electrophoresis for the separation and identification of proteins.

Evaluate the accuracy of existing techniques, such as silver staining or fluorescence measurements, for the quantification of micro quantities of proteins resulting from analytical scale separations of complex mixtures and develop new methods based on neutron activation analysis.

Develop methodology for the application of NMR spectroscopy to the identification of specific proteins, their substrates and products in complex mixtures.

Evaluate new chromatographic materials for the separation of proteins and peptides with high performance liquid chromatography; evaluate the relationship of protein structure to separation in metal-ion affinity chromatography; and investigate the use of supercritical fluid chromatography for the separation of biomolecules.

Evaluate the systematic use of immunoglobulins for the detection, separation, and quantification of proteins and their substrates and products - including their application to chromatographic separations and to electrochemical detection.

Develop techniques for accurate in situ locational analysis of biomolecules.

Develop advanced mass spectrometric techniques to detect high molecular weight compounds for the quantification of biomolecules.

C. Bioprocess Monitoring and Separation and Purification of Products

Why this is important:

The OECD and OTA reports both emphasize the need for new and improved methods for bioprocess monitoring. They note, for example, that many biological products are unstable unless handled within a limited range of pH and temperature. Process monitoring is required in order to assure continued optimal operation. Many critical variables are capable of being monitored only by withdrawing samples from the reaction vessel and analyzing them off-line. Even then, it is difficult to determine key characteristics accurately. When measuring cell mass, for example, most process operators simply note such crude indicators as packed cell volume, turbidity, or, at best, dry weight. The constituents of bioprocesses are fragile. Turbulent flow can destroy cells and denature proteins, but some degree of mixing is required in order to bring vital nutrients to the cells. Methods are needed for measuring flow in viscous, heterogeneous fluids. Methods are needed for measuring cell mass and vitality. Methods are needed for monitoring product concentrations. The requirement of sterility is always a complicating factor in the design of new monitoring techniques.

In addition to monitoring methods, reference data are needed for solubilities of dissolved gases and nutrients in reaction media as functions of temperature and pH. Such reference data are needed in order to relate measurable parameters to reactor performance.

The OECD and OTA reports also emphasized the need for new and improved methods for the separation and purification of products. Very few products from bioprocesses are volatile, so gas phase processing, which is widely used in the chemical industry, is seldom possible. Therefore, recovery from the dilute aqueous solutions characteristic of bioprocesses depends on solid/liquid separation methods, but the low relative densities of the biological solids and their compressible nature makes this difficult. The complexity of the reaction mixtures requires new, highly selective recovery techniques that leave as little residual product as possible in the medium. The selection and evaluation of appropriate separation methodology will rely on reference data on the performance of separation methods.

What NBS will provide:

- Evaluation of the applicability of novel measurement techniques for bioprocess monitoring.

- Reference data on thermophysical properties of fluids and gases characteristic of bioprocesses.

- Reference data and mathematical models for separation techniques based on generalizable properties of bioprocess broths, products, and separation media.

Techniques such as molecular spectroscopy, which are widely used for chemical analysis, have potential use as monitoring instruments in bioprocesses, particularly when combined with fiber optics. Fluorescent microscopy techniques coupled with cell- or element-specific fluorescent dyes may prove valuable for continuous, non-invasive, on-stream monitoring of biological processes. Acoustical methods may also prove useful for process monitoring in bioreactors. Even if the complexity of bioprocess reaction broths precludes direct, in situ monitoring of specific compounds, it may be possible to relate spectroscopic responses to the overall operating conditions in the reaction vessel. Reference data will therefore be required in order to establish such relationships.

As noted in IV.A above, mathematical models are the complement of reference data. Models extend the range of and verify the internal consistency of reference data. Having both reference data and mathematical models related to solid/liquid separation methods, engineers will be able to decide among competing separation techniques for particular processes and to assess the performance of separators.

Program objectives:

Develop methods for the measurement of turbulent flow in viscous, inhomogeneous fluids and provide mathematical models for the description of turbulent flow appropriate to the design of biochemical reactors.

Evaluate spectroscopic, fluorescence, and light scattering techniques for aseptic monitoring of reactants, products, and cell concentrations in bioreactors.

Develop thermodynamic models for describing the operating environment of bioreactors in terms of monitorable parameters for use in computer control of bioprocesses.

Develop theoretical models for characterizing membrane separation of products from reaction broths, with emphasis on reversible complexation, in terms of generalizable properties such as polarizability, ionizability, electrolytic strength, and size.

Evaluate supercritical extraction as a method of separation of polar products from dilute aqueous solutions and develop theoretical models for describing the performance of supercritical extraction.

Develop chemical speciation methodology for evaluating the mechanisms of microbial solubilization of elements from solid substrates and of precipitation of selected elements from process streams.

V. RELATIONSHIP TO THE PROGRAMS OF OTHER INSTITUTIONS

Measurements are not an end in themselves, but are conducted to serve some purpose. Moreover, the purposes of measurement determine the nature of the measurement process itself. NBS participates in the programs of other Federal agencies to observe first hand the role measurement plays in accomplishing the goals and objectives of their programs. NBS plays host to research associates from industries all over the country in order to understand the commercial and industrial purposes of measurements. NBS scientists participate in the work of voluntary standards bodies in order to be knowledgeable in the standards needs of the scientific and technical community in general. NBS involvement with other institutions goes beyond the imperative of minimizing duplication of effort and keeping abreast of advances in scientific knowledge. Collaboration with other institutions is integral to the accomplishment of NBS' mission.

In the following sections, the roles and activities of various institutions involved in one way or another with biotechnology are discussed and compared with the activities of NBS.

A. OTHER GOVERNMENT AGENCIES.

The expectation that biotechnology will play a significant role in the economic growth and vitality of the U.S. and concerns over the health and safety consequences of increased research, development, and production activities involving biotechnology have led to extensive interest in biotechnology in several government agencies. Interagency coordination is accomplished through a number of interagency committees including the Interagency Risk Management Council for the coordination of regulatory policy development, the Recombinant DNA Advisory Committee, the Committee on Food, Agriculture, and Forestry Research of the Federal Interagency Committee on Science, Engineering, and Technology and the Office of Science and Technology Policy (OSTP), and most recently the Cabinet Council Working Group on Biotechnology which was formed to review Executive branch activities in biotechnology. In addition, several informal interagency working groups have been formed including the Informal Biotechnology Working Group initiated by personnel of the the Office of Naval Research, the Interagency Committee on Plant Biology convened by personnel of the National Science Foundation and an Interagency Working Group on Competitive and Transfer Aspects of Biotechnology, convened by OSTP to address issues on the transfer of biotechnology abroad.

The major issue in interagency coordination at this time is the resolution of regulatory jurisdiction in biotechnology. The immediate resolution of this issue does not rely on measurement capability, though the eventual course of regulatory development will require extensive measurement methodology.

NBS coordination with the work of other agencies is conducted primarily at a scientific level through interagency committees and joint research programs. NBS has participated in the OSTP Interagency Working Group on Competitive and Transfer Aspects of Biotechnology and on the Informal Biotechnology Working Group initiated by personnel within the Office of Naval Research. The Department of Commerce represents NBS views on nearly all of the existing interagency coordinating committees. NBS is also called upon by other Federal agencies for quality assurance services associated with the data acquisition and measurement method development programs of those agencies.

The following paragraphs summarize the programs of other Federal agencies and indicate areas of potential NBS involvement in those programs. As it has with other technologies, NBS will provide measurement services to other agencies on a cost reimbursable basis when NBS services are needed by those agencies to accomplish their mission, when the services are specific to the mission of those agencies, and when those services are consistent with the NBS mission. However, none of the other Federal agencies has or will have responsibility for the development and maintenance of a measurement system for biotechnology. Of course, other agencies, like the scientific community in general, will continue to draw upon the measurement base developed by NBS within its own program.

Department of Agriculture

The Department of Agriculture has responsibility under the Virus-Serum-Toxin Act (21 USC 151-158) for regulating animal biologics. The USDA also conducts research in new and improved strains of plants and animals and in new uses for existing plant crops which can be modified by fermentation processes. Estimates of support for biotechnology research in fiscal years 1983 and 1984 are $34.7 million and $36.2 million respectively. NBS work in the development of measurement methods for the monitoring and control of bioreactors could be used by USDA-supported scientists conducting research in improved methods of fermentation, but the delivery of NBS services here would be identical to services offered more broadly to the entire biotechnology industry. Similarly, USDA-supported scientists could use NBS services to assure the accuracy of the determination of the nutritional value of various food stuffs, but such use would be common to any determination of the chemical composition of biological materials.

Department of Defense

The Department of Defense conducts research and development in biotechnology to develop measures to protect military personnel from infectious diseases and from chemical and biological agents. In addition, it is interested in specialized applications such as antifouling measures for naval vessels. The overall level of support has been estimated to be $7.5 million in 1983 and $21 million in 1984. NBS has worked in a variety of areas with DOD, and in recent years has provided DOD with chemical and biological measurement methods and critical data related to the fouling of naval vessels. DOD is also sponsoring research into the application of biotechnology to extract and process strategic materials, especially metals. NBS is working with the Office of Naval Research on a program to develop and apply measurement methods for determining the bioprocessing parameters of metal extraction by thermophilic bacteria. NBS is also working with DOD on biologically-mediated waste management and recycling. DOD, however, does not support the development of measurement methodology required for the commercialization of biotechnology.

Department of Energy

The Department of Energy sponsors research in several of its programs on the use of biotechnological approaches to produce energy from biomass. Such approaches could include the development of new organisms capable of producing large quantities of methane or molecular hydrogen, or organisms capable of converting lignocellulose biomass to methanol and ethanol. In conducting such research, DOE may develop sensors and separation techniques for the specific process being developed, but the sensors and separation techniques will not necessarily be generalizable. NBS and DOE have conducted joint research in the past requiring NBS expertise in monitoring, reference materials, and reference data, and such working relationships are expected to continue in the future.

Environmental Protection Agency

The Environmental Protection Agency is currently evaluating its regulatory strategy for biotechnology. The Toxic Substances Control Act and the Federal Insecticide, Fungicide, and Rodenticide Act are currently viewed both within and without the agency as providing the most likely framework for regulations aimed at protection of the environment and human health. Regulations may require monitoring techniques for genetically modified organisms introduced into the environment, but such requirements are still quite far into the future. EPA will develop monitoring methodology, but may require NBS SRM's for validation of monitoring methodology. EPA will not be in a position to develop a measurement basis for the commercial development of biotechnology.

Food and Drug Administration

Under the Food, Drug and Cosmetic Act (21 USC 301-392), the Food and Drug Administration has authority to regulate food additives, human and animal drugs, and medical devices such as in vitro diagnostics (many of which will be based on monoclonal antibody technology). Data required by FDA for product licensing may rely on traceability to NBS standards to demonstrate accuracy and reliability. NBS has worked extensively with the FDA in the area of clinical chemistry. Responsibility for the development of measurement standards resides with NBS.

National Institutes of Health

The National Institutes of Health supports extramural and conducts intramural basic research in molecular biology at a level of about $380 million. Much of the progress in biotechnology over the past decades has been a direct result of research supported by NIH. NIH does not have a program relating to commercial development of biotechnology. (It did have a so-called biotechnology program which was, in fact, a biomedical materials and engineering program which will be renamed to avoid confusion with the currently accepted definitions of biotechnology.) Nor does NIH have responsibility for assuring the reliability of data collected by other than their own scientists and grantees. NIH can be expected to request reference materials from NBS for the evaluation of measurement methodology used in NIH studies. NBS and NIH scientists have collaborated on joint research projects relating to the structures and properties of biomolecules and NBS will draw upon the expertise of NIH scientists and the results of NIH research in the development of its measurement standards program.

National Science Foundation

The National Science Foundation is expanding its role in biotechnology with emphasis on enzymes and enzyme technology, organisms adapted to extreme environments, plant and animal cell culture, bioreactors, sensors, raw material substrates, separation and purification of products, microbial processing, biochips, and the application of biotechnology to materials engineering and processing. These areas of biotechnology are supported in over 30 different programs. The level of support was approximately $60 million in 1984, and is estimated to reach $125 million in 1986 and $250 million by 1990. NSF also uses a variety of approaches in fostering university-industry interactions, primarily through the Industry/University Cooperative Research Project Program. This program supported $1.1 million in biotechnology projects in FY 1983 and is expected to support $1.3 million in FY 1984.

The NSF programs in enzymes and enzyme technology, sensors, and separation and purification complement those of NBS and NBS uses the science base which is developed through NSF funding in the development of its own measurement services. However, NSF does not maintain a program of measurement services such as the provision of reference data or reference materials.

B. INDUSTRY

NBS is involved directly and continually with industry - from the time a program is first planned through the actual provision of measurement services resulting from Bureau research. This is often done through collaborative arrangements. In common with most scientific institutions, the NBS technical staff communicates with scientists in institutions throughout the world by actively publishing in the peer-reviewed literature, by attendance at scientific meetings, and by collaborative efforts with individual scientists engaged in complementary research. Beyond these professional interactions however, NBS actively pursues cooperation with industry through a variety of mechanisms including its Visiting Committee and National Academy of Sciences - National Research Council Boards of Assessment, guest workers and research associates, and participation in voluntary standards organizations. Through formal agreements, NBS pursues public domain research in cooperation with industrial organizations. For example, the Electric Power Research Institute is currently supporting NBS research into the biological benefication and liquefaction of domestic coal.

NBS has sponsored workshops and symposia on measurement-related issues in biotechnology. These meetings involve industry and are a valuable means for gaining consensus on measurement standards needs. For example, NBS has recently sponsored workshops on standards needs associated with electrophoresis and with biomass conversion. NBS staff members are currently helping to organize a Workshop on Biotechnology for the Mining, Metal-Refining, and Fossil Fuel Processing Industries.

NBS continues to solicit the views and opinions of industry in developing its plan for measurement services and standards for biotechnology. Some of the industries assisting NBS with its plans are identified in Section III of this report. The NBS Visiting Committee and the NAS\NRC Boards of Assessment of the NBS research groups where the biotechnology work will be conducted include representatives from industry. Through them, industrial representatives review on a continuing basis not only the plans for providing measurement services and standards for biotechnology, but also the quality of the scientific work itself. As it has in its other programs, NBS management will communicate directly with industry management and with representatives from trade associations in planning and conducting biotechnology programs.

NBS sponsors an industrial research associate program which brings over 100 visiting scientists and engineers from industry to NBS each year. These research associates'salaries are paid by their parent organizations or by trade associations while they work with NBS staff on measurement problems of mutual interest. To speed accomplishment of its goals in biotechnology, NBS will actively promote its industrial research associate program throughout the country, attracting to NBS scientists and engineers from industry who are expert in various applications of biotechnology. NBS will be able to offer the associates a unique range of measurement capabilities. The associates, in turn, will provide NBS with information on the measurement needs of industry.

The voluntary standards system in the U.S. fosters collaboration among industries and between industry and government to the benefit of producers, consumers, and government alike. By participating in voluntary standards development in the U.S. - and with international organizations seeking to reduce non-tariff barriers to trade - NBS scientists maintain an up-to-date awareness of standards needs and contribute directly to improved measurement methodology. Typically, reference or standard measurement methodology is developed and disseminated by the voluntary standards bodies. Measurement services offered by NBS are used to evaluate developing methodology and to sustain the performance of accepted methodology. Two organizations currently involved with or beginning involvement with biotechnology are the National Committee for Clinical Laboratory Standards and the American Society for Testing and Materials.

The National Committee for Clinical Laboratory Standards (NCCLS) was incorporated for the purpose of promoting the development of national and international standards for clinical laboratories as a means of:

- Improving the quality of work performed in clinical laboratories.
- Benefiting public health, safety, and welfare.
- Facilitating communication and understanding.

NCCLS provides the clinical laboratory community with a mechanism for defining and resolving problems relating to standards which influence the quality of work performed in clinical laboratories. NCCLS committees and subcommittees, consisting of over 1000 volunteers, are working on standards for enzyme assays, reference materials, analytical methods, and protocols used to evaluate analytical instruments. Membership in NCCLS is open to any public or private academic, scientific, professional, governmental or industrial organization, corporation or agency based in the U.S. Currently, nine government agencies (state and Federal, including NBS), 24 professional societies and over 100 industries hold active membership in NCCLS. NBS scientists are active in both the standards writing activities of NCCLS and in the leadership of NCCLS.

The American Society for Testing and Materials (ASTM) is the largest standards-writing body in the U.S. It consists of approximately 30,000 members working in 137 standards-writing committees and annually publishes 6700 standards. NBS scientists currently hold over 400 positions in nearly all of the society's committees, chairing several of them. During the past four years, the ASTM Committee on Research and Technical Planning has been assessing the needs for voluntary standards in the field of biotechnology. NBS scientists have participated in this assessment which has included visits to industries involved with the applications of biotechnology. In September 1984 a report was presented to the ASTM Board of Directors on biotechnology. ASTM plans to form a new committee in this area in the near future, and NBS scientists will play an active role.

C. UNIVERSITIES

NBS interactions with university scientists parallel its interactions with scientists from industry and other non-academic institutions. NBS scientists collaborate directly with university scientists in joint research programs and scientists from universities spend sabbatical periods at NBS. Postdoctoral Research Associates from universities throughout the country work with NBS scientists through a program administered by the National Research Council. University scientists with relevant backgrounds serve on the NBS Visiting Committee and on the NBS Boards of Assessment.

As is the case with most NBS activities, the NBS plan for measurement services and standards for biotechnology was developed with advice and guidance from university scientists, many of whose institutions are identified in Section III of this report.

In certain instances special programs are initiated between NBS and near-by universities. For example, staff of the Center for Chemical Engineering at the Boulder, Colorado, laboratories of NBS are currently collaborating with members of the faculty of Chemical Engineering at the University of Colorado and Colorado State University. This collaboration is planned to include joint work on separation and purification problems in biotechnology. The Center for Chemical Engineering has also recently signed a memorandum of understanding with Lehigh University for collaborative research on instrumentation for bioprocessor monitoring.

D. CENTER FOR ADVANCED RESEARCH IN BIOTECHNOLOGY

To gain greater access to expertise in the biological sciences and expand technology transfer, NBS is planning to cooperate with the Center for Advanced Research in Biotechnology (CARB). The mission of the center will be to combine interdisciplinary, biotechnology-related resources from academia, industry, and government in an organization that will serve as a national resource for biotechnology-related measurement research and services.

Originally, CARB was to be a joint venture between NBS, the University of Maryland, and industry. Since this original concept, an alternative approach has been suggested which is being pursued. This new approach is to broaden participation to create a consortium of universities from around the country. The broadening of this involvement is designed to accomplish three objectives:

- To gain the involvement of the widest range of scientific expertise possible in the biological sciences
- To gain the involvement of a wide range of industrial applications through the industrial relationships of the participating universities

- To ensure that the services provided by CARB address measurement problems of broad national interest.

To date, the University of Florida, the University of Washington, the North Carolina Biotechnical Institute, Pennsylvania State University, and the University of Michigan have expressed interest in participating in this joint venture.

Cooperation with this center will not only give NBS an additional means for technology transfer, it will bring to NBS a greater awareness of specific national measurement needs than it could obtain through its more traditional channels.

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Mr. **Brown**. I am going to yield to Dr. Ritter for any questions he may have. I suspect we're all very proud of the new initiatives that you have described this morning, but we may want to focus a little bit more on some of the deinitiatives that you have described also. Mr. Ritter.

Mr. **Ritter**. Thank you, Mr. Brown.

I would just like to focus a little bit on NBS's role as kind of a leading national lab which has had a good track record of working on key areas of industrial competitiveness and working closely with industry.

I would like to know what, in your opinion, are some of the reasons that the Bureau of Standards has such a tough time, particularly around budget time when supposedly you're doing the kinds of things that all of us are asking for?

Mr. **Ambler**. Mr. Ritter, I did follow with very close attention your statement at the beginning of this hearing, and my own remarks at the beginning of my testimony were——

Mr. **Ritter**. I apologize. We had another Energy and Commerce important hearing over there.

Mr. **Ambler**. Well, I felt very pleased because what I had already written was parallel to what you were saying, and the phrase I used, that the NBS is a national laboratory, is very much in tune with the times for all the reasons that you mentioned.

Now, when you look at the NBS budget and you look at the proposals for increases and decreases, I think you have to do so in the context of things other than the individual merits of the program. I don't think any of us are pretending that the ICST programs are not good programs. I think one has to look at them in the context of the Federal budget as a whole and the need to control the deficit. And I am not an economist and I don't know much about deficits and interest rates, but the economists seem to say that that has a big effect on the industrial and business strength of the United States, too. Therefore, when we're faced with these hard choices, we have to weigh the various programs in the National Bureau of Standards.

I would like to say, Mr. Ritter, that our budget, of course, goes through the Department of Commerce, and I have been very heartened in recent years, particularly this year, in the very strong support Mr. Baldrige has given to us, particularly in these initiatives. And I think his general philosophy about technology and the economy is pretty much the same as yours and as mind.

Mr. **Ritter**. I sometimes wonder how budgets at this stage of the budget process are developed, and I get the feeling that if an organization doesn't have a political action committee, it's usually right up there for cuts and, second, if it doesn't have a good, strong constituency, it faces similar difficulties as well.

You do have, although it's not really geared to influence the process in any way, but you do have a very strong industry constituency that really believes in the kind of things that you've done in terms of the cooperative efforts.

I mean they wouldn't put their own money in, they wouldn't put their own people in, they wouldn't support the efforts over the years because they see NBS having some of these cooperative ventures as the only game in town, that this has been taking place over the last decade.

So I think it suffices to say that there are people out there who, if they're interested in National Bureau of Standards programs, should make their voices heard.

Dr. Schwartz, first, you talked about Japan having a 50-percent share of the industrial or engineering ceramics market. Why did that happen? How did that happen? What's our share?

Dr. SCHWARTZ. Well, it is not 50 percent, obviously, because the rest of the world is also involved in this effort. It happened, in large measure, I think, as many of the technological and industrial advances have occurred in Japan in the last decade by focusing of effort and identification of long-term goals, harnessing the technological base of the country and directly coupling it to effort.

Mr. RITTER. But it's one company in the substrate area that is really adding a gigantic amount to this overall base.

Dr. SCHWARTZ. Well, there is always a technological advantage for that company which develops the technology first.

Mr. RITTER. Well, that technology was developed in the private sector.

Dr. SCHWARTZ. The technology was actually a result of applications of research that had been going on for some years, and it's in some measure the ability of that company to transfer that basic research into a technological follow-up which gave them the advantage.

Mr. RITTER. Was that basic research a world-level research that they then took and applied in their own products?

Dr. SCHWARTZ. Yes, that's essentially correct, in this case.

Mr. RITTER. Again, you know, it brings us to something beyond perhaps these hearings, but there seems to be this one arena where, you know, you take the world-level research and then you commercialize it and then you build a market share. Is NBS involved with industry at that level? We could end up winning a lot of Nobel Prizes and the Japanese will develop by far and faster the first ceramic engine. I mean it's amazing to me that here is Toshiba getting into the engine business as basically an electronics company, although they have a lot of other companies. But they're not afraid. This kind of technological mobility, I mean, it's like IBM—IBM plus just a big consumer entertainment industry, with the manufacturing capability that they have—but I mean here's that kind of company getting into the manufacture of engines for automobiles and other situations. I think it's a phenomena.

Dr. SCHWARTZ. In answer to your question regarding NBS's interaction with industry in this regard, I will refer you to your earlier statement about NBS and just indicate that in the area of advanced ceramics, it's our intention to continue the process that we've been using I think rather effectively for many years, and that's a direct interaction with industry, the incorporation of industrial research associates into our programs.

Mr. RITTER. Is there any other similar activity going on nationally in terms of this field, which I think if we're left at the starting gate in this revolution because of weight factors and wear factors and temperature factors and there's a revolution in engine manufacturing and we're not in it, I think it would have a disastrous effect on our own automobile industry.

Dr. **SCHWARTZ**. I couldn't agree with you more. I think, though, that we can point to substantial effort on the part of the Department of Energy and NASA, these are federally funded programs, and to considerable effort on the part of a number of U.S. manufacturing companies.

Our point at this juncture in time is that we have entered into that "war" of which you have spoken, and it's important that we maintain our effort and increase it in order to get a share, and a competitive share, of this huge worldwide business.

Mr. **RITTER**. Anybody who thinks automobiles is a smokestack industry anymore, I think somebody should write letters to all those people who wrote books talking about what was smokestack and what was high-tech, because it just doesn't apply. So much of this so-called high-tech that demands 1,500 people sitting at a table assembling things with their fingers is eminently exportable and some of what people think is lower-tech is eminently more automatable and produced here and not necessarily needed to be exported.

What about the cold neutron facility, why NBS and not another Federal lab?

Dr. **AMBLER**. There are very good reasons why NBS, Mr. Ritter, and that has to do with the nature of the reactor we already have. The people that designed the reactor were—very foresighted when they designed it, so there is space inside the reactor for a very large cold neutron section. And then there is room, with the building addition that we're speaking about, for a very large number, 15, experimental stations. That's a capability that's not matched by any other reactor in this country.

Mr. **RITTER**. And also, your history of working closely with the private sector would make this eminently available in a way that's already developed.

Dr. **AMBLER**. Yes; and it already is to the extent that we can with the facilities we have. We don't have the cold neutrons, but thermal neutrons are used by industry, too.

Mr. **RITTER**. Let me close with one question, and this is a tough question but I would appreciate your honest answers. Does NBS still retain the characterization as a truly first-class scientific establishment, engineering establishment, can attract and hire the world's best and that is world-level competitive, or have things changed over the last decade or decade and a half?

Dr. **AMBLER**. I think we still have that reputation. Now, I would not say that in one area or another we may not have difficulty competing for the very top people, for whatever reason. But speaking as an institution, I feel that we are. I think we have to understand that the nature of the National Bureau of Standards is such that we're involved in a very broad range of scientific and engineering disciplines serving a very broad range of clientele; therefore, the research that supports that is diverse also.

But in the research that we do, I think we are world competitive. In one of the interesting observations—for instance, the post-docs tell me—I meet the post-docs every year when they come through, and then after they've had a bit of time—is the extreme interest in the institution because of that breadth. There are people available that seem to know something about whatever particular problem they're interested in for their own purposes at the present time.

So I think if you take that into account and do not, say, compare us with Fermi Lab, which has one singular function to perform in the high-energy physics, but treat us on our own merits. In fact, the way you described it, I think we are. And if we didn't, I would feel very worried about it. But I don't, really.

Mr. RITTER. Thank you, Mr. Chairman.

Mr. BROWN. Thank you, Mr. Ritter.

Mr. Bruce.

Mr. BRUCE. Just three questions. The President's budget claims a 13-percent increase in research and development, yet your budget has been cut by 10 percent for operating. Would you explain to me why you've taken such a large cut when other agencies are experiencing fairly large increases?

Dr. AMBLER. I haven't looked at figures for other R&D agencies in detail, though from what I hear, your presumption is correct. I think it's to be understood in terms of priorities within the administration, of which the reduction of the deficit and holding down the budget at the highest levels is probably the most important consideration, and an evaluation of the various options so that coming forward with increases that support industrial competitiveness on the one hand and offset by decreases is a result of factoring in what many people feel we must do to hold down the Federal budget.

Mr. BRUCE. Did you make a larger budget request to OMB and have it cut back?

Dr. AMBLER. Yes, we did, sir.

Mr. BRUCE. Did they give you any logic on why your budget was cut to the extent it was, 10 percent?

Dr. AMBLER. The cuts are in the area of fire, buildings and ICST, and those cuts have been before this committee for, I think this is, the third year. The rationale for cutting them is no different this year than in previous years, from the point of view of program or who will do them or in terms of the general reasons of the deficit.

Mr. BRUCE. Well, going on with that, the whole budget cut question, in your budget document you make the statement about, "The need is probably never greater for accurate scientific measurement and testing," yet in that portion of your budget you submitted a budget which cuts that area. Can you explain the inconsistency between the statement that we need ever-increasing accuracy and a cut in your program?

Dr. AMBLER. Well, first of all, I do subscribe very strongly to that remark that we do need to have a broadening of more accurate measurements and data. I suppose it comes down, working within overall constraints as to total, at this particular time what seemed to be more important to address was the most pressing national issues—namely, the economy, and when you drive that analysis through, it comes out the way you see it in the budget, sir.

Mr. BRUCE. In the Grace Commission report they recommended a change in the ratio between technicians and professionals, that you had too many professionals to the number of technicians. Do you agree with their recommendation, and if so, have you made any change in that ratio?

Dr. **Ambler**. Yes, we agreed to some extent. And, yes, we have. We have been working on that very hard. In fact, this last year we increased the number of technicians by 40, and at the same time we're increasing the scientific and professional staff by about half that number.

Mr. **Bruce**. One final question, Mr. Chairman, on supercomputer. The National Science Foundation made grants yesterday. What would be your operational mode within the NSF supercomputer system and your own? Do you have the staff? You said you'd make it operational by April 1. Will new staff be hired? Whoever answers that question, I would appreciate some explanation of your supercomputer program.

Dr. **Ambler**. Dr. Lyons will answer that question, sir, if you agree.

Mr. **Bruce**. Please.

Dr. **Lyons**. Well, the last part of your question first, if I may, Mr. Bruce. We do have enough staff to get up and running. We are hiring more, and these kinds of people are difficult to hire. But we have enough core staff already aboard to get going, and we are adding a few as we go along. Those were authorized last time.

The NSF announcement of, I think it was, five sites where they will invest very substantially in hardware and presumably software and staff, is for a different mode of operation than we have planned. Our computer, which is available already for three DOC agencies, will also be available outside but only, at the moment anyway, on the following basis: that if there is a scientist or engineer in the private sector or at other levels of government, who has a common interest or makes common cause with an NBS employee—that is, he enters into a technical collaboration—then the computer will be available.

Now, to the extent that those folks are located in universities, there is a question of whether we should somehow link into the NSF program. NSF also plans to put a network among these computers, and we are going to have some discussions with NSF as to the role of other computers not in their own group of computers and should we get on their network. And I would think the answer would be, "Yes."

Mr. **Bruce**. Will you be seeking requests for time and proposals for use of the supercomputer? How do you plan to utilize its time? Will it be through a technical committee?

Dr. **Lyons**. We are not going to sell time.

Mr. **Bruce**. No, I am not talking about selling time, just utilization. Surely, you will have more projects than you can put on the computer in a year's time.

Dr. **Lyons**. Well, we certainly hope so. There will be a ramping-up period. The supercomputer does different kinds of problems than we have been able to do on our current equipment, so that there is a learning process already underway. When the time comes that the facility is in effect sold out, yes, we will have to have techniques for allocating those resources. We have already begun thinking about that. We have a committee we just appointed to deal with allocation of resources. Presumably, that will be a function of the top management of the bureau to set that up and police it.

Mr. Bruce. Do you have a coordinating committee with the National Science Foundation on their supercomputer program?

Dr. Lyons. No; but there is some cross-membership on advisory committees, and we know what they're doing. There is no formal committee yet.

Mr. Bruce. Thank you,

Thank you, Mr. Chairman.

Mr. Brown. Thank you, Mr. Bruce.

Dr. Ambler, in past years' testimony with regard to the ICST, the fire research, and building research, we have explored with public witnesses whether or not there would be a capacity within the private sector to pick up the programs that were being proposed to be zeroed out there. And the tenor of that testimony, as I recall it, was that there was little, if any, chance that that would occur. Do you know of any change in that situation, any indication that the building research or fire research or computer standards activity would be picked up by private industry?

Dr. Ambler. We also have been working very assiduously to see if we could accomplish that—without much success. Maybe Dr. Lyons would like to say something about the fire program in particular, where he has been working quite hard.

Mr. Brown. Dr. Lyons.

Dr. Lyons. Well, we've been having conversations both in the building community and in the fire research community. In the case of fire research there was a National Fire Research Strategy conference held at the National Fire Protection Association headquarters in Quincy last summer. Indeed, Chairman Walgren was in attendance at that meeting.

The purpose of that was to consider, because of the budget proposals, who should do what in fire research. And we went through a lengthy process of assessing the needs of fire research and then indicating the roles for the various sectors. It was very clear what the manufacturers of sprinklers and detectors and so on should do. It's reasonably clear, I think, what State and local governments and the building officials should do.

Then there is a need for basic research, and of course, the participants thought the Federal Government ought to worry about the basic research.

The minutes of that conference are available, and I think the Chairman already has a copy.

In the case of the building community, we are in constant communication with organizations like the National Institute for Building Science, the National Conference of States on Building Codes and Standards, the National Research Council's group which is now called the Building Research Board, and various parts of the construction industry.

They're concerned and interested. I can't report the same kind of progress that I think we've seen in fire research.

Mr. Brown. What about in the computer field, Dr. Burrows, is there any chance that Bobby Inman's new facility would be interested in picking up some of the work that you're doing, or other arrangements be made in the computer industry to accomplish some of this?

Mr. **Burrows**. We do have contacts with the group in Texas, the MCC. They are mostly interested in developing new proprietary—I would say, the seeds for new products. And so that is what they are concentrating on. There is also a new group in the software area setting up on the West Coast. They have expressed interest in working with us, but not in taking over what we're doing.

There are some areas, like in networking, where at this time industry is developing products to meet those standards. And in engineering and developing a new product, they really have needs for testing which are far beyond our ability to support. And I think there is some indication that they will indeed be very much interested in taking over that testing activity, and we had no intention of doing that in the first place. Developing the test is one thing, but doing the testing is another. They may even be interested in further development of those tests, and I think that's the area in which we are probing at the time.

The one thing that industry is quite willing to do is when it looks like you have a winner on your hands, they're quite willing to exploit it. Getting the seeds of new ideas into action, like in protocols, the networking stuff started 10 years ago, and it's just now that they're getting interested in actually putting products out.

Mr. **Brown**. Dr. Ambler, I am looking at the spreadsheet showing what you had originally requested for the Department of Commerce and then what finally came out, and it does appear that you did get considerable support at the level of the Secretary of Commerce but not very much support at the level of OMB.

Let me ask just one or two items here. You indicated in your original request to the department apparently that you could use more money on that cold neutron facility. What would that have meant in terms of speeding up the operational date for that facility if you had been able to get the amount that you had originally requested, $14 million?

Dr. **Ambler**. We were planning on getting the thing operational in 3 years, and by paring down the request to what you see, it's being stretched to a 4-year program.

Mr. **Brown**. A 4-year program. I was rather intrigued also, the Secretary apparently wanted you to spend some money on the steel industry, and I understand that the administration is proposing that one of the national labs become involved in steel industry problems, but your role was eliminated in OMB. Do you have any further insight on what the reasons for that might be? Obviously, they're concerned about the steel industry, but not too interested in NSB doing anything about it.

Dr. **Ambler**. Yes; the other Federal laboratories were Argonne and Oak Ridge, and this is a project that not only Mr. Baldrige and Dr. Keyworth are interested in. I don't think any of the requests for appropriation in the steel area are appearing anywhere in the 1986 budget. But Mr. Kammer knows the details better.

Is that correct?

Mr. **Kammer**. Yes.

Dr. **Ambler**. I guess my answer is correct.

Mr. **Brown**. There is nothing in any budget item covering the steel industry at this point?

Dr. **Ambler**. Not in ours nor in any other budget.

Mr. Brown. Are they sneaking it in without putting it in the budget?

Dr. Ambler. No, sir; as I think you know, we do have a program jointly with the American Iron and Steel Institute, which we started several years ago, again anticipating this area for sensors development. And that funding is still in the budget, so we're going to continue to do that.

Mr. Brown. All right. There is an item here on electronics, a new initiative that you apparently were proposing. Does that have to do with this fiberoptics that we're expanding so rapidly at the present time?

Dr. Ambler. Yes, it does, sir. We're already working in our Boulder laboratories through redirecting some of the radio frequency and microwave effort to the measurements on the optical fibers themselves. But this proposal was dealing with a wider range of measurements that would be required for the total communications system. So it was a proposal that would start us moving into providing services in the optical communications area, analogous to the basic services we now provide, for example, in the microwave area or the radio frequency area. So that was what it was all about.

Mr. Brown. Do you have any hint as to whether or not these items are of sufficient priority that they might be included in future budgets, that we're just holding up here because this is the year of the freeze or something like that?

Dr. Ambler. Well, without predicting future budgets in any precise detail, from my own point of view, I fully intend to raise with the department programs which I feel are going to be supportive to the economy in the way I have described. And I see no reason for changing my mind about any of the proposals I have made to date. It's simply the ones that do come through in the President's budget, were by agreement of us all the highest priority ones. So that's why you see cold neutrons, for example, right up at the top.

Mr. Brown. Getting back to biotechnology for a moment, the administration has been quite supportive of more research in this area. They've added an initiative in the Department of Agriculture, for example, on plant biotechnology. Could you give me an indication of the kind of firms that you're involved with at NBS in this area and whether or not they feel the need for you to become actively involved, more actively involved?

Dr. Ambler. Would it be okay if Dr. Johnson answered that?

Mr. Brown. By all means.

Dr. Johnson. Certainly, Mr. Brown. We have, over the past 3 or 4 years, been in a fairly constant dialog with both large companies and small. We have been talking with, for example, Dupont. I have been to Dupont to visit their new Life Sciences Center to take a look at what they're doing and talking about the directions they're going. They have worked with us. Dupont staff people have served with us on advisory panels, helping us determine directions and determine needs.

We've had similar kinds of visits at Kodak exchanging ideas back and forth. We've had dialog with Hewlett-Packard, with many others in the large-company arena. We have also been working with many small companies, some of them local, like Genex, which is right down the road from us. We've had very intimate collaborations working on a technical basis, and we've been talking with people from many other small companies.

We've tried very hard to develop a fairly clear consensus of what the industry really needs from the research level, planning processes for research through the scale up through real production. So I think we've had a lot of interest expressed.

Mr. **Brown**. All right. There are some other questions that we would like to submit to you gentlemen in writing, if we may, and have your response to them.

I think that will conclude our hearing for this morning, unless you would like to add anything, Dr. Ambler. You've had enough? [Laughter.]

Dr. **Ambler**. It's a little hard to answer that question because this is one of the most understanding subcommittees that I appear before. So I think, though, in view of the hour, for this morning I have had enough, sir.

Mr. **Brown**. All right.

Thank you very much. It's always a pleasure to have you here. You're a real success story, I think, for Government agencies, and we're pleased to have a chance to discuss your work with you.

With that, the subcommittee will be adjourned.

[Whereupon, at 12:03 p.m., the subcommittee was adjourned.]

1986 NATIONAL BUREAU OF STANDARDS AUTHORIZATION

THURSDAY, FEBRUARY 28, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research and Technology,
Washington, DC.

The subcommittee met, pursuant to notice, at 2:50 p.m., in room 2325, Rayburn House Office Building (Hon. George E. Brown, Jr.) presiding.

Present: Representatives Walgren, Brown, Bruce, Boehlert, Cobey, and Ritter.

Mr. Brown. The subcommittee will come to order. We apologize to the witnesses for the delay in getting started. We've been running a little behind all day, and it'll probably get worse before it gets better.

We welcome the distinguished panel this afternoon, and we will get right to business.

The chairman, who is temporarily detained, has an opening statement and, without objection, that will be placed in the record at this point.

[The opening statement of Hon. Doug Walgren follows:]

OPENING STATEMENT
HON. DOUG WALGREN
NATIONAL BUREAU OF STANDARDS AUTHORIZATION

FEBRUARY 28, 1985

TODAY WE BEGIN OUR SECOND DAY OF HEARINGS ON THE NATIONAL BUREAU OF STANDARDS' BUDGET REQUEST FOR FISCAL YEAR 1986.

WE LEARNED ON TUESDAY THAT THE ADMINISTRATION ONCE AGAIN IS PROPOSING DRAMATIC CHANGES AT THE BUREAU. ITS PROPOSED BUDGET CUTS EQUAL APPROXIMATELY 25% OF THE AGENCY'S FISCAL YEAR FUNDING AND ARE PARTIALLY OFFSET BY MODEST NEW EFFORTS IN BIOTECHNOLOGY AND CERAMICS AND CONTINUATION OF ONGOING INITIATIVES DEALING WITH PROCESS AND QUALITY CONTROL TECHNOLOGY AND THE COLD NEUTRON SOURCE AT NBS'S RESEARCH REACTOR. OVERALL THE OPERATING BUDGET OF THE BUREAU IS REDUCED BY ABOUT 10% IF THE IMPACT OF INFLATION IS NOT CONSIDERED.

WE DO NOT TAKE SUCH DRAMATIC CHANGES LIGHTLY. WHILE WE RECOGNIZE THE NEED FOR STANDARDS IN EMERGING TECHNOLOGIES, WE VALUE THE CURRENT PROGRAMS OF THE BUREAU AND ARE PUZZLED WHY YEAR AFTER YEAR THE SAME IMPORTANT PROGRAMS ARE OFFERED UP FOR SACRIFICE.

OUR APPROACH TO THESE HEARINGS IS TO BUILD AS FULL A RECORD AS TIME PERMITS SO THAT COMMITTEE MEMBERS WILL BE WELL-INFORMED WHEN THE TIME TO MAKE HARD CHOICES ARRIVES LATER THIS MONTH. WE HAVE INVITED EMINENTLY WELL-QUALIFIED EXPERTS TO SPEAK ON THE IMPORTANCE OF EACH OF THE NEW INITIATIVES AND ON EACH OF THE PROGRAMS SLATED FOR REDUCTION OR ELIMINATION. THIS WILL REQUIRE ONE MORE DAY OF HEARINGS ON THE NBS

BUDGET THAN WE HAVE HAD IN RECENT YEARS, BUT WE FEEL THIS IS NECESSARY TO ACHIEVE OUR OBJECTIVES.

TODAY WE ARE PLEASED TO HAVE WITH US DR. RUSSELL MEYERAND, WHO CURRENTLY SERVES AS THE CHAIRMAN OF THE NBS STATUTORY VISITING COMMITTEE AND MR. JOSEPH O'GRADY, THE EXECUTIVE VICE PRESIDENT OF THE AMERICAN SOCIETY OF TESTING AND MATERIALS TO GIVE US OVERALL PROSPECTIVES ON THE BUREAU'S BUDGET REQUEST. ALSO ON OUR FIRST PANEL WILL BE DR. ARTHUR HUMPHREY, ACADEMIC VICE PRESIDENT OF LEHIGH UNIVERSITY, AN AUTHORITY ON BIOTECHNOLOGY, AND MR. ROLAND "PETE" ENGLAND, THE PRESIDENT OF THE NATIONAL CONFERENCE OF STANDARDS LABORATORIES, WHO WILL DISCUSS THE BUREAU'S PROGRAMS IN PROCESS AND QUALITY CONTROL TECHNOLOGY. LATER WE WILL HEAR FROM MR. JOHN GOSDEN, VICE PRESIDENT OF EQUITABLE LIFE ASSURANCE SOCIETY WHO WILL DISCUSS THE IMPACT OF THE PROPOSED CUTS IN THE NBS COMPUTER PROGRAM AND MR. WILLIAM CONNOLLY AND MR. THOMAS MOSES WHO ARE INTIMATELY FAMILIAR WITH NBS'S BUILDING AND FIRE RESEARCH PROGRAMS AND THE VACUUM THAT MIGHT BE LEFT IF THESE PROGRAMS ARE ABOLISHED.

I UNDERSTAND THAT DR. HUMPHREY IS OVERDUE FOR A PRESENTATION AT THE NATIONAL ACADEMY OF SCIENCES, SO WITHOUT FURTHER DELAY WE INVITE YOU TO PROCEED. IN LIGHT OF OUR LATE START WE INVITE EACH OF YOU TO SUMMARIZE YOUR PREPARED TEXTS WHICH WILL BE INSERTED IN THEIR ENTIRETY IN THE HEARING RECORD.

Mr. BROWN. Our first panelist this afternoon will be Dr. Arthur E. Humphrey, provost from Lehigh University.

I recognize our distinguished colleague from Pennsylvania who will make a few remarks. I failed to note that Lehigh is the institution that he's from.

Mr. RITTER. I thank the chairman for his indulgence, and I would like to welcome our distinguished panel and, in particular, a friend and colleague, Dr. Arthur Humphrey, provost of Lehigh University, one of the foremost biochemical engineers in our country and also a man with vision who is seeking to help people like us to explore the emerging, exploding field of biotechnology in the most effective way he knows how. I thank you, Dr. Humphrey, for being with us.

Mr. BROWN. Dr. Humphrey, we are very pleased you could be here and I should say I have an outstanding institution of higher education in my district which wishes to become preeminent in biotechnology, and everything you say I'm going to carry back to them.

STATEMENT OF DR. ARTHUR E. HUMPHREY, PROVOST, LEHIGH UNIVERSITY, BETHLEHEM, PA

Dr. HUMPHREY. Thank you Mr. Chairman. I'm very pleased to be asked to testify here. I'm also pleased to testify on a panel here in which we're in front of the Honorable Don Ritter from Pennsylvania. We're very proud of him because he came from Lehigh, was properly trained, and has a doctor of philosophy, as you know. We're very proud to have a representative like that in the U.S. Congress.

Mr. BROWN. Having intelligence is a major handicap to being a Congressman.

Dr. HUMPHREY. He has many other attributes, too. Otherwise he wouldn't have won by such an overwhelming vote.

I want to talk to you about critical needs in biotechnology today, and I brought my 75 copies here with me that may be passed out for those that would like to have my formal statement. The United States is the world's leader in biotechnology research. There are potential dangers and challenges to this leadership. Particularly when it comes to commercializing biotechnology. I would like to speak today to ways to minimize those dangers in part through support of the National Bureau of Standards program in biotechnology. Specifically, I would like to direct my remarks to those other aspects of biotechnology; not gene splicing, but bioprocessing. Genetic manipulation only provides the opportunities; it is bioprocessing that brings these opportunities to commercial realization.

I do not need to remind this committee that we are at war; an economic war in commercializing high technology. Biotechnology is one such technology. The spoils of this war are great; the order of $100 billion per year by the year 2000. With regard to bioprocessing, it was your own Office of Technology Assessment [OTA] that stated in its February 1984 report on commercializing technology, "The competitive advantage in biotechnology depends as much on the developments in bioprocess engineering as on innovations in genetics, immunology, and other areas of basic biological science."

Now what was not answered in the OTA report was what research is needed with respect to bioprocessing. In my opinion, a process data knowledge base is needed that will enable us to design and scale up bioreactors where we can carry out the growth of a wide range of cloned cells including plant, animal, and microbial cells; a data base that will enable us to design and scale up separation and purification operations that will provide us with the basis for the recovery of these bioproducts; and a data base which will provide for the development of biosensors and process control algorithms enabling optimal control of these bioprocesses.

A question that this committee must answer is why can't the development of this knowledge be left to the private sector? The answer lies in the character of the biotechnology industry. Of the nearly 250 companies involved in biotechnology, 100 were formed in the last 5 years. Few of these companies have yet to build their first plant or to sell their first product. Unlike the Monsantos and the Du Ponts, these emerging companies have no commercial base to do process research. Their present concern is to identify, test, and obtain approval for products of their research.

The National Bureau of Standards can and must play a key role in developing the needed process data knowledge base. I believe the proposed National Bureau of Standards program in biotechnology would help do two things: First, establish the needed fundamental knowledge base to support the design, scale up, and optimal control of reactors and process for large-scale growth of microbial plant and animal cells that is required for the full exploitation of this new biology; second, it would provide and help develop the fundamental knowledge base for large-scale separation and purification processes that will be required to produce the spectrum of potential bioproducts.

In passing, I would draw a comparison between the emerging biotechnology industry with that of the mature chemical industry. In the chemical industry, there already exists a well-developed thermodynamic and kinetic knowledge base. Any new chemical company can draw upon this knowledge base to design their processing. We need to establish in this country a similar data knowledge base to support biotechnology process development.

A lot was done by the National Bureau of Standards for the chemical industry. Now we need to provide this same support basis for the emerging biotechnology industry.

What are the consequences of not doing this? In my formal statement, I cited a number of lost opportunities to Western Europe and Japan in the related fields of enzymes and amino acids. For example, although we initiated the amino acid industry here, today almost all of the amino acids are produced in Japan. We initiated the enzyme industry but today, because of better process basis, 21 of the 26 enzymes that are commercialized come from Japan.

The reason for this is that the United States pursued in these fields only first entry research strategies. They did not follow through in developing the process knowledge base to sustain a competitive position. The petrochemical industry stands as a contrary example to this. The United States still dominates through intensive process research, the petrochemical industry of the world. Again, let me reiterate my main point; we must not give away our overwhelming lead in basis biotechnology research by failure to provide the knowledge base to fully commercialize this research.

Now I want to summarize. Future action of the U.S. Government must recognize that commercialization of biotechnology research is not opportunity limited. Rather, the principal limitation is the lack of a data knowledge base to address the optimal design and control of processes for commercializing bioproducts of this technology.

Congress can, in my opinion, through the support of the National Bureau of Standards biotechnology initiative address the lack of an adequate process data knowledge base and can help meet the foreign challenge to this emerging biotechnology industry.

Thank you very much for listening to my comments.

[The prepared statement of Dr. Humphrey follows:]

CRITICAL NEEDS IN BIOTECHNOLOGY

A Statement by
Arthur E. Humphrey
Academic Vice President
Co-Director - Biotechnology Research Center
Lehigh University
Bethlehem, PA

The phenomenal progress over the past decade in molecular biology and biochemistry now makes it possible to genetically engineer living cells of all types - microbial, plant and animal - to generate products for a seemingly unlimited variety of commercial opportunities. These range from products for human and animal care, agriculture, environmental protection and natural resource utilization. Estimates of the world-wide demand for biologically derived products range from 40-100 billion dollars by the year 2000. The United States is presently the world leader in research in biotechnology. However, there is a danger that the United States may not be able to maintain this leadership and as a consequence may not fully reap the benefits from the fruits of commercializing biotechnology. This is a critical danger to which the U. S. Congress must be sensitive.

Recent reports from the OTA and from an NRC Committee on Biotechnology agree that in the next decade, the competitive advantage in biotechnology may depend as much on developments in bioprocess engineering as on innovations in genetics, immunology and other areas of basic biological science. What is meant by bioprocess engineering and why are developments in bioprocess engineering so critical to successful biotechnology commercialization?

Bioprocess Engineering or more popularly Biochemical Engineering is that area of expertise that translates knowledge developed in biological and biochemical science into practical industrial processing. The Biochemical Engineer bears the same relationship to the life scientist as the chemical process engineer does to the chemist. Biochemical Engineers enriched by active involvement in the "new" biology can provide the necessary knowledge base to meet the challenges we face in commercializing biotechnology. This knowledge base will enable the designing of processes to produce these bioproducts and scaling up these processes to a commercially feasible operation.

The establishment of this knowledge base will require the cooperation of academia, government, and industry.

Why can't the development of this bioprocess knowledge base be left to the private sector? The answer lies in the character of the biotechnology industry. At the present time, nearly 250

U. S. companies are involved in the commercialization of biotechnology. One half of these companies have been established in the last decade. Roughly 100 are less than 5 years old. More than 5 billion dollars from the private sector has been spent to capitalize these new companies. Few have yet to build a commercial plant to produce their first product. Most are in the product development and testing stage.

Since virtually all bioproducts are high unit value materials, there is little concern at first in optimizing the process for their production until the commercial value of the product has been established. As a consequence, many "new" biology companies initially make their products virtually in pails. A new company cannot afford to spend their precious investment dollars on process research until the value of their product(s) has been established. However, to maintain a competitive advantage one must not only have the best product but also a product made by the most economical process. To achieve this an adequate knowledge base must exist to enable the:

1. design and scale-up of bioreactors
2. design and scale-up of separation and purification operations
3. development of biosensors and process control algorithms enabling the control of the process.

The National Bureau of Standards can and must play a key role in developing this knowledge base. The proposed National Bureau of Standards initiative in Biotechnology would help:

1. Establish the fundamental knowledge base to support the design, scale-up and optimal control of reactors and processes for the large scale growth of microbial, plant, and animal cells required for full exploitation of the new biology.
2. Develop the fundamental knowledge base for large scale separation and purification processes that will be required to produce the spectrum of potential biochemical products.

What are the consequences of NOT doing this? The present U. S. lead in Biotechnology research is being frittered away to the Japanese and Western European countries who are poised to establish commercial positions in biotechnology by practicing effective and forward looking bioprocess engineering. For virtually no cost they are utilizing our basic research in biotechnology which is made conveniently available to them through the open literature.

Past case histories will illustrate lost opportunities in related fields because of a lack of aggressiveness in U.S. research in process engineering. For example:

The U. S. consumer was spared much of the world sugar crisis through bioreactor technology based on Japanese patents. This technology uses a continuous, immobilized-enzyme process that converts the glucose derived from domestic cornstarch to high-fructose corn syrup, a commercial sweetener. The process, with $1.5 billion annual sales, now uses $50 million annually of immobilized enzyme purchased from European companies.

U. S. companies led the world in manufacture of amino acids prior to the 1960s. Then, an intensive Japanese effort began to improve amino acid production through biological and biochemical engineering techniques. First, classical genetic strain improvement techniques were applied to isolate mutant micro-organisms that produced greatly increased quantities of amino acids. Second, biochemical engineers utilized very large bioreactors and developed efficient methods for recovering the product. Today, Japan dominates a business with annual world sales of $1.7 billion.

Process technology for penicillin manufacture was developed in the United States in the 1940s. Protected by patents, several U. S. companies dominated the world penicillin market for many years. Now that the patents have expired and U. S. companies have decided to invest in research on new, higher return products rather than on process improvement, European companies with modern process technology account for the preponderance of worldwide sales of natural penicillin.

Japan and Western Europe can be expected to be no less aggressive as the results of U. S. research in the "new" biology diffuse abroad. Foreign developments in Biochemical Engineering already attest to that aggressiveness. For example:

Basic technology for membrane separation of biomolecules was invented in the United States, but the Germans and Japanese are the ones applying it to separations of enzymes and amino acids from complex mixtures.

Technology for very large (400,000 gal) continuous fermenters was developed and is being practiced in the United Kingdom. This development pushes biochemical engineering to limits not yet explored in the United States.

Although the use of fermentation to produce ethanol is an ancient technology, more efficient immobilized-cell, continuous processes have been conceived, and Japan, not the U. S., has established the first demonstration-scale plant.

A survey of biochemical engineering research and education in the United States, Western Europe, and Japan indicates a striking difference between U. S. and overseas activities in the magnitude and organizational structure of the government-supported research and development effort in biotechnology. West Germany, Japan, and the United Kingdom each have three federally supported institutes dedicated to biotechnology; there are none in the United States. These nine institutes bring together academic and industrial investigators, feature cross-disciplinary activities, and have impressive operating budgets.

In 1983, the West German Gesellschaft für Biotechnologische Forschung (GBF) had an operating budget of DM37.1 million ($14 million), and the Institut für Biotechnologie II in Jülich had DM11.1 million ($4.3 million) for biochemical engineering alone. The last figure essentially equals the entire NSF annual budget in biochemical engineering. A quantitative comparison of space and associated equipment for biochemical engineering shows that West Germany's research space is nearly double that of the United States.

In Japan, the MITI 10-year plans have strong research and development components in biochemical engineering; three of the nine areas emphasized are bioreactors, animal cell culture, and membrane separation. Japanese government support of membrane separation research and development alone amounted to $20 million in 1983. The comparable NSF effort is less than $1 million.

It is obvious that countries such as Germany and Japan are laying a foundation of research and trained personnel as part of their strategy in preparing for intense international competition in the arena of biotechnology. The potential economic rewards for success are very great. As indicated earlier the estimates of the potential worldwide markets for biologically derived products fall in the range $40-$100 billion annually by the year 2000, corresponding to about 15 percent of the estimated total annual market for chemicals. First entry into these markets will be critically important in international competition, and major shares of the world-wide bioproducts market will be captured by those countries who possess the needed national capability in research and personnel.

The U. S. Government must recognize that commercilization of the fruits of the "new" biology are not opportunity - limited. Rather that the principal limitation is the lack of a technical knowledge base to address the optimal design and control of processes for making these bioproducts.

Through support of the National Bureau of Standards biotechnology initiative to address this knowledge base need, Congress can in part help meet this foreign challenge to the U. S. industry. I urge you to take action that will aid commercializing biotechnology for the maximum benefit of the U. S. as well as the world population.

Mr. **Brown**. How much time do you have, Dr. Humphrey?

Dr. **Humphrey**. As much as you would like.

Mr. **Brown**. I was just wondering if we should allow for some questions of you now or if you could wait until we finish with the whole panel.

Dr. **Humphrey**. When I say as much as you would like, I need to leave by 4:30 p.m..

Mr. **Brown**. We'll accommodate that without any difficulty. We'll proceed with Mr. England. Would you go ahead with your statement.

STATEMENT OF ROLLIN "PETE" ENGLAND, PRESIDENT, NATIONAL CONFERENCE OF STANDARDS LABORATORIES: ACCOMPANIED BY H. BRYAN WERNER, EXECUTIVE VICE PRESIDENT AND GEORGE RICE, PAST PRESIDENT

Mr. **England**. Thank you Mr. Chairman. My name is Pete England and I am the current president of the National Conference of Standards Laboratory. I have submitted written testimony which more directly addresses the fiscal year 1986 NBS budget item identified as process and quality control.

We previously testified before this committee in 1983 and submitted written testimony in 1984. I come before you again this year to speak on behalf of those domestic members of our organization who are not directly affiliated with Federal Government activity.

I would like to address three points in my remarks today: (1) the U.S. National Measurement System and our perceived role for NBS in that, (2) our membership concerns over the perceived deterioration of NBS capability, and (3) some brief comments or projected impact statements if that trend continues.

First, the U.S. National Measurement System; what is it? It consists of several thousands—maybe tens of thousands—of organizations, laboratories, institutions, and agencies linked together, both voluntarily and by regulation, in an effort to ensure that their individual measurement requirements are right. This is done through a process of comparison to higher accuracy standards and it also includes the attendant traceability of those measurements to some recognized national standard, most of which reside in the Bureau. We firmly believe as an organization that the U.S. National Measurement System nurtures every element of American science and industry. If we talk about equity in trade, if we talk about commerce both here and abroad, science and technology, product quality, the universality of engineering and production, health and safety which affects all Americans, the economy and security of this Nation; these all depend heavily upon this National Measurement System.

We think it is appropriate that the National Bureau of Standards sit at the apex of this pyramid—a pyramid that must be both cohesive and coherent as well as having a high level of integrity. We believe as an organization that it is the charge and primary mission of the Bureau to monitor and provide a degree of stability to this National Measurement System.

I would like to make a few comments about process and quality control. We all recognize the need for U.S. industry to improve product quality and reliability. But, we strongly believe that as U.S. industry strives to improve the quality of their products, as they strive to implement newly developed quality improvement programs, it is almost counterproductive to allow the foundation for those methods to be eroded. Which leads me into my second point.

The express concerns of our membership over the perceived deterioration of the Bureau's capability is to meet the needs of American industry. Because of that concern, which started to surface in 1980, we as an organization through a standing committee within our organization, identified as the National Measurement Requirements Committee, undertook a rather extensive study and survey of our membership and all those others that were involved—that we could identify—in the measurement and standards field. The results of this comprehensive study were compiled and published in 1983 and presented to the Bureau to aid them in prioritizing their measurement service work. At about the same time, but independently of our survey, the Bureau had developed an evaluation of its own. That proposal was reviewed by a task team of members from both industry and Government and resulted ultimately in an initiative in the amount of $13.5 million.

Our written remarks before this subcommittee last year deplored the failure of the administration to request that full amount of $13.5 million which we felt was needed to restore these essential services to an acceptable level. These were core measurement requirements needed now. They were not long-term or out-year requirements. Of course, we as an organization strongly supported the reduced request of $2.5 million last year, of which only $560,000 was eventually appropriated by Congress.

The proposed budget item that we have before us today includes an increase in the amount of $1.94 million for fiscal year 1986 identified as process and quality control. Of course, we strongly support this request, but also, with equal strength, we deplore the failure to increase that request to $12.9 million which would fully fund the original initiative, and in our opinion meet these more critical core measurement requirements of American industry today.

As far as impact statements as to what is going to happen in the future, I'll limit it to one area in the interest of saving time. We as an organization and through another committee from IEEE, have developed—in industry—a committee to promote national standards. In this particular area, it has to do with trying to set up and establish some standards for millimeter wave technology. I call your attention to page 3 of our written testimony where we are attempting to resolve this very critical measurement problem that we feel should be rightly addressed by the Bureau now.

Others have identified and published facts and figures dealing with this one issue and stating that approximately $5 to $6 million is needed annually over a 5-year period just for this one area of standards work identified as millimeter wave technology.

To summarize briefly, I would like to reemphasize that precision measurements are a basic aspect of every area of science, research, and technology. However, we feel very strongly that without an ongoing and continuous research and development program at the national level into all aspects and components of measurements, without an effective and practical delivery system of the results of that R&D back to industry, and without a strong and viable national measurement system that the long-term impact to this country's leadership in high technology, and to its health, economy, and security will be in jeopardy. We as an organization and those of us who work in the measurement science field feel very strongly that the Bureau is a national asset. What is done for it today—or to it today—will determine the health of that institution for years to come. We owe it to our future not to let these capabilities deteriorate any further.

That basically concludes my remarks and I thank you again for having the opportunity to present them to you today.

[The prepared statement of Mr. England follows:]

WRITTEN TESTIMONY FOR THE RECORD

TO THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

ON BEHALF OF

THE NATIONAL CONFERENCE OF STANDARDS LABORATORIES
INDUSTRIAL SEGMENT

BY

PETE ENGLAND, PRESIDENT

H. BRYAN WERNER, EXECUTIVE VICE PRESIDENT

AND

GEORGE RICE, PAST PRESIDENT

FEBRUARY 28, 1985

Mr. Chairman and members of the subcommittee, my name is Pete England and it is my priviledge to appear before you today on behalf of the industrial segment of the National Conference of Standards Laboratories (NCSL). I am the President of NCSL and with me today are George Rice, immediate Past President and Bryan Werner, Executive Vice President.

I believe a few of you have some familiarity with our organization; however, for those who are not, allow me to briefly describe it. We are a non-profit, laboratory oriented organization designed to promote cooperative efforts toward solving the common problems faced by standards laboratories in their organization and operation. We have a membership of over 650 organizations and agencies throughout the world. We've grown by some 150 members since appearing before this committee two years ago.

Our appeal to you today is on behalf of the commercial, industrial, and other non-governmental segments of our membership, with regard to that portion of the NBS FY86 budget which addresses Process and Quality Control. The governmental agency laboratories, which also hold NCSL memberships, continue to express their views and needs in this same area of concern through their proper and established channels.

The NCSL continues to very closely follow the National Bureau of Standards (NBS) in many of their activities. However, our major interest and thrust is that of pursuing activities we recognize as necessary to ensure that the health and adequacy of the national measurement system is maintained to properly support the needs of industry, commerce and the defense of the United States. The NBS plays the key role in this process by providing the basic standards and measurement techniques to all segments of the measurement community. This support has deteriorated to the point of inadequacy in many measurement disciplines and is non-existant in others - an intolerable condition to say the least. Both funding and staffing levels for NBS have been insufficient to carryout research and development in support of advanced measurement programs and standards requirements.

Our industrial and commercial membership is as concerned about the Federal budget deficit as are the Members of this Committee, indeed, as are most Americans. And we are well aware that there will be difficult times as the Congress is required to make the tradeoffs between or among competing purposes of limited Federal funds. We also recognize that these difficult choices will occur not only among the various agencies of government, but, in many cases, between projects within individual agencies. And perhaps this is the way it should be. Our role is to convince you of the importance that the mission of the NBS has for the nation - for today and into the future.

We firmly believe that proper application of the funds provided in the Administration's proposal would slow down the deterioration seen in the services provided by the NBS in this vital, albeit unglamorous, area. It would not, however, restore these services to their previous levels of unquestioned superiority and quality. This would require additional funds to create and/or upgrade those services which are nonexistent or which have been allowed to deteriorate over the past decade.

Process and Quality Control Initiative

The proposed budget before you includes an increase in the amount of $1.94M for "development of primary standards and measurement methods to improve industrial productivity through improved process and quality control..." This follows the request last year for $2.5M for FY85 of which Congress appropriated $0.56M.

In our written remarks to the Committee last year, we strongly supported the request for $2.5M and deplored the failure of the Administration to request the full amount of $13.5M which two separate evaluations of the conditions at the NBS in this mission area had disclosed was necessary. This year, again, we strongly support the Administration's request for the remainder of the $2.5M initiative ($1.94M for FY86) and (equally strongly) deplore the failure to increase the request to fully fund the entire $13.5M ($12.94M for FY86) needed to restore these essential services to an acceptable level.

In just one area (RF and microwave), concern for the lack of NBS capability is so great that it has led to the formation of an ad hoc committee within the IEEE. This committee to Promote National Microwave Standards (PNMS) has identified a number of deficiencies in the NBS which, although having a significant impact in the defense and intelligence sectors, are of increasing importance in the non-defense sector as well. We cite this example not just to mention the importance of this one sector, but rather to bring to your attention that this one sector is but the tip - a highly visible tip, to be sure, but nonetheless just the tip - of an iceberg that looms beneath the surface. This nation cannot afford to let other measurement areas within the Bureau's mission deteriorate to such a level as to require the formation of additional " Committees to Promote National Standards". All deterioration must be halted; new and improved services must be developed and provided; the U.S. National Bureau of Standards must once again be allowed to reach its proper place as the world's pre-eminent laboratory for standards and standards dissemination.

As mentioned last year and alluded to before, two separate evaluations were made, both of which support this initiative. The NCSL Committee on National Measurement Requirements undertook an extensive survey of its members and others involved in measurements and standards work. The results of this study were provided to the NBS to aid that institution in prioritizing its measurement services work. At about the same time, but independently, the Bureau had developed an evaluation of its own. This proposal was reviewed by a group of industry specialists which ultimately resulted in the original initiative in the amount of $13.5M. There was a remarkable consistency between the two evaluations.

Industry, commerce, defense - indeed every facet of the American economy - depend upon the standardizing role of the NBS and, consequently, upon the improvements which will be made possible by this initiative. Improvements in industrial productivity arise not just from the application of automated machines (although these certainly are important); they arise also from improvements in methods and measurements which contribute to improve quality. The higher the quality of our production processes, the less loss we have from repair and scrap, and, consequently, the lower are our costs. And lower costs are certainly one factor in the productivity equation. Lower costs are also a major factor in our ability to compete internationally.

It is for the foregoing reasons that, as a minimum, the increased $1.94M funding should not be reduced or allowed to be traded away in favor of other programs or requests. Thank you.

Mr. BROWN. Thank you very much Mr. England. I should have said for all of you that the full text of your statements will appear in the record.

Dr. Meyerand.

STATEMENT OF DR. RUSSELL G. MEYERAND, JR., VICE PRESIDENT—TECHNOLOGY, UNITED TECHNOLOGIES CORP., HARTFORD, CT

Dr. MEYERAND. As chairman of the Statutory Visiting Committee for the National Bureau of Standards, I'm pleased to appear before the Subcommittee on Science, Research and Technology to present the visiting committee views on NBS. Besides myself, the visiting committee has four members: Dr. Bernard M. Oliver, vice president (retired) of Hewlett Packard Co.; Dr. Norman F. Ramsey, Higgins professor of physics at Harvard University; Dr. Robert H. Pry, president of the Center for Innovative Technology, and Mr. William D. Manly, senior vice president of Cabot Corp.

Dr. MEYERAND. The visiting committee is required by law to report annually to the Secretary of Commerce on the operations of the Bureau of Standards and the state of its equipment. In arriving at its findings and recommendations, the committee meets twice a year. At one of those meetings the committee receives reports of the National Academy of Sciences and National Research Council Boards of Assessment chaired by Dr. William P. Schlicter of Bell Laboratories. There are 18 board of assessment panels with 188 members from industry, academia, and other Government agencies who serve without compensation to examine the entire work of the National Bureau of Standards.

Let me begin by reporting that the visiting committee is very impressed by the high quality of the technical activities, by the expertise and dedication of the staff, and by the relevance of NBS programs to the critical needs of our Nation.

I now will encapsulate my remarks and hit some of the high points. First of all, the committee strongly supports the four budget increases in the four major new initiative areas. They are the cold neutron facility, process and quality control, biotechnology and advanced ceramics. Dr. Humphrey has already spoken extensively about the biotechnology so I will proceed on beyond that.

The cold neutron facility, for which an increase of $8 million is sought, will provide a truly exceptional facility to do diagnostics on materials that are not visible to common x rays. You can detect hydrogen, for instance, which is very important in brittling ceramics and metals. Those studies can be carried out using the cold neutron facility.

Process and quality control, which Mr. England has already spoken to, is very important. The $1.9 million is welcome but more could certainly be used.

The $3 million increase this year for the work in biotechnology, I completely agree with Dr. Humphrey, is certainly a step in the right direction. It is a very, very important field to this country and to the citizens in it.

The Advanced Ceramics Program, which has not been mentioned, is a $3.5 million initiative and will allow NBS to provide the scientific base, measurement methods, key data, and predictive concepts needed by U.S. industries for the development of reliable advanced ceramics with reproducible and controlled properties. There are a number of high technology applications for which the unique properties of advanced ceramics are especially well suited. Because of their resistance to wear, corrosion, and high temperatures and their unusual optical, electrical, and magnetic properties, they are used in many electronics applications, in engines that achieve greater efficiency by operating at higher temperatures, and as cutting tools for the metal working industry.

However, in the area of other budget concerns, while the visiting committee enthusiastically supports all four of the budget increases, we are extremely concerned about several of the proposed decreases. This is the third year in which the Fire and Building Research Programs have been targeted for elimination, yet the Center for Fire Research provides the scientific and technical basis for efforts to reduce the Nation's fire losses and the cost of fire protection. Each year fires result in 7,600 deaths, more than 200,000 severe injuries, and $30 billion in direct and indirect property losses. The Center for Building Technology provides nonproprietary research for the large but disparate U.S. building industry which contributes almost 10 percent of the GNP. Two-thirds of the Nation's wealth is invested in constructed facilities provided by this industry.

In support of the President's drive to cut domestic spending and achieve a significant reduction in the deficit, NBS plans to eliminate the centers for fire research and building technology. However, the visiting committee is concerned that the life-preserving research conducted by these two groups will not be adequately performed elsewhere.

Also, this is the fourth year in which substantial reductions have been proposed to be made in the Institute for Computer Science and Technology. The programs proposed for reduction provide research and development work in standards, information resource management, and computer security—all serving the needs of both vendors and users alike.

I would like to point out that in view of the tight budget situation, NBS management has made significant cuts in the general administrative and equipment budgets. NBS management is confident these cuts can be made at no jeopardy to the technical program in the short run. The budget for general administrative functions, such as travel, printing, consulting, and overall management, is being reduced by $8.2 million.

The equipment acquisition budget is being reduced by $3.3 million, or approximately 25 percent. The visiting committee cautions, especially with regard to the equipment budget, that such reductions cannot be continued from year to year without having an adverse effect on the technical program.

Before concluding I'd like to express our particular concern about the mandated reduction in the number of professionals in grades GS 11 through GS 15. The effectiveness of all of the programs at NBS is seriously jeopardized by this proposal. Although we understand and even encourage attempts to reduce midmanagement bulge, these are the grades occupied by most of the scientists and engineers at NBS. Recent Ph.D. level graduates are normally recruited at the GS 11 or GS 12 level.

NBS is implementing this required reduction by replacing only two of every three vacancies arising by attrition in this grade range in the technical areas and none of the vacancies in the administrative and managerial ranks. Promotions from GS 9 to GS 11 have been frozen.

The consequences of this reduction are particularly serious for recruiting new staff with expertise in the special kind of scientific computing that will be done on the new advanced computer facility at NBS. But the restriction is indeed damaging to all the technical programs. It appears that NBS is the victim of a decision made for another purpose. While the intent may have been to reduce middle management, the quality of the technical staff is jeopardized. Relief from this mandate should be given to NBS.

In conclusion, I appreciate this opportunity to state my views and those of the visiting committee on these most important matters concerning the budget for the National Bureau of Standards. Thank you.

[The prepared statement of Dr. Meyerand follows:]

STATEMENT OF
DR. RUSSELL G. MEYERAND, JR.
VICE PRESIDENT-TECHNOLOGY, UNITED TECHNOLOGIES CORPORATION
HARTFORD, CONNECTICUT

CHAIRMAN, NATIONAL BUREAU OF STANDARDS
STATUTORY VISITING COMMITTEE

BEFORE THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
ON AUTHORIZATION OF APPROPRIATIONS FOR THE ACTIVITIES OF THE NATIONAL BUREAU OF STANDARDS

FEBRUARY 28, 1985

As Chairman of the Statutory Visiting Committee for the National Bureau of Standards, I am pleased to appear before the subcommittee on Science, Research and Technology to present the Visiting Committee views on NBS. Besides myself, the Visiting Committee has four members: Dr. Bernard M. Oliver, Vice President (Retired) of Hewlett Packard Company; Dr. Norman F. Ramsey, Higgins Professor of Physics at Harvard University; Dr. Robert H. Pry, President of the Center for Innovative Technology, and Mr. William D. Manly, Senior Vice President of Cabot Corporation.

The Visiting Committee is required by law to report annually to the Secretary of Commerce on the operations of the Bureau of Standards and the state of its equipment. In arriving at its findings and recommendations, the Committee meets twice a year. At one of those meetings the committee receives reports of the National Academy of Sciences/National Research Council Boards of Assessment chaired by Dr. William P. Schlicter of Bell Laboratories. There are 18 Board of Assessment panels with 188 members from industry, academia, and other government agencies who serve without compensation to examine the entire work of the National Bureau of Standards.

Let me begin by reporting that the Visiting Committee is very impressed by the high quality of the technical activities, by the expertise and dedication of the staff, and by the relevance of NBS programs to the critical needs of our Nation. The research programs continue to support the long-term mission of NBS, and at the same time Bureau management has been extremely successful in focusing skills and programs on the most urgent national priorities.

Continued growth and strengthening of our economy depend upon the application of science and technology to preserve the quality and international competitiveness of U. S. industries. This is one of the goals of the Department of Commerce and one of the three goals of the President's Science Policy. The National Bureau of Standards is uniquely responsible for providing the scientific basis for measurement methods and standards that support American industry.

As an example of this type of support, NBS is playing a key role in the development of consensus standards for computer interfaces and measurement techniques for testing computer protocol performance. Last July in Las Vegas the National Computer Conference featured a demonstration of two computer networks that resulted from a cooperative effort by NBS, General Motors Corporation, Boeing Computer Services, and 13 computer manufacturers. NBS developed the test methods that supported the development and implementation of the computer interface standards and enabled the companies participating in the demonstration to assure that their computer products would work together using international network standards.

Industrial interest and support of NBS programs is evident in the extent to which industry and universities join with NBS in cooperative research efforts. During FY 1984 NBS research activities were enriched with 153 Industrial Research Associates, 523 guest workers (most participating at no cost to the government), and other cost-sharing programs through which industry provides assistance-in-kind for activities of mutual interest and benefit. These cooperative programs are precisely the kind of effort that this country must encourage to meet the economic pressures of increased international competition.

The Automated Manufacturing Research Facility (AMRF) is an outstanding example of a cooperative research program. In the AMRF, NBS is working with industry, universities, and other government agencies to improve quality control and productivity through better use of automated machine tools. Industry has loaned and donated equipment, 24 research associates have been sponsored by a number of companies, and there have been guest workers from several universities.

This NBS research program is developing methods for assuring quality control in a fully-automated manufacturing environment and standards to permit computer-controlled machine tools and robots made by different manufacturers to work together through standardization of computer interfaces. Automation is very critical for U.S. manufacturers to compete in foreign and domestic markets. Other industrial countries, including Japan and Germany, have major national programs in automation.

The last meeting of the Visiting Committee was held earlier this month on February 6, at the Bureau of Standards in Gaithersburg. At that time, NBS Director Dr. Ernest Ambler reviewed the FY 1986 budget for us and we discussed some of the issues that it raised. The Visiting Committee understands the severe constraints placed on the budget by the strong commitment of the Reagan Administration to reducing the federal deficit. We were mindful of these constraints as we reviewed NBS activities and have considered the merits of the budget issues in this context. The fact that this budget calls for program initiatives in spite of the pressures to reduce federal spending is indicative of the overall importance of NBS activities in supporting the economic well-being of our nation.

The Visiting Committee strongly supports the budget increases proposed for major program initiatives at the Bureau of Standards. These initiatives are: 1) cold neutron facility; 2) process and quality control; 3) biotechnology; and 4) advanced ceramics. All four of these initiatives relate directly to the NBS mission and support research in areas vital to U.S. industry because a fundamental measurement and science base is essential for technological advancement.

Cold Neutron Facility

A budget increase of $8 million will provide funds needed to initiate construction of a national facility for cold neutron research. A cold neutron facility can probe materials much like an X-ray does metals and bones, but it can see elements such as hydrogen, which X-rays cannot detect. This capability makes the facility a superior research tool for investigating polymers and ceramics. A recent National Academy of Sciences report by the Seitz Committee gives top priority to the construction of cold neutron facilities, an area in which the U. S. is far behind other industrial countries. The NBS reactor is the only one in this country designed to allow the installation of a cold source of sufficient volume to handle a large array of instruments.

The requested funds for FY 1986 will permit the addition of four new beam ports to support 15 experimental work stations, four of which are expressly designated for industrial use. With the Bureau's outstanding reputation for encouraging high quality cooperative research, it is ideally suited to work with industry in developing the measurement capabilities that are critical for characterizing the properties and performance of advanced materials.

U. S. science and industry urgently need a facility for conducting cold neutron research and the proposed facility at NBS offers the best opportunity to meet these needs.

Process and Quality Control

The Visiting Committee strongly supports the proposed increase of $1.9 million to provide new and improved measurement services for more effective process and quality control. Clearly the NBS mission mandates attention to the urgent needs in this area. In order to remain competitive, U.S. industry must increase its efficiency and exercise greater control over the quality of manufacturing processes. New measurement methods and services must be available to meet the new and increasing demands brought about by automation and other advances in technology.

Yet NBS must continue its current services which remain in great demand. The average value added to U.S. products from measurement-related activities is 3.5 percent of the GNP; the lack of quality control has been estimated to add 20 percent to the cost of industrial sales.

The $1.9 million increase will permit development of new measurement services in three high-priority areas: radiometric calibrations essential for the lighting, photographic, and electro-optics industries; automated electrical impedance measurements of use in industries such as precision measurement, electrical power, and automobile manufacturers; and microwave measurements important for advanced communications and aerospace systems. Even with pressure to reduce federal spending, programs which promise such high payoffs must be funded, especially since there are clear demands for the program from throughout American industry.

Biotechnology

This is the second year in which the NBS budget has included a request for $3 million to provide needed physical, chemical and engineering measurements in support of the rapidly emerging area of biotechnology. Biotechnology is changing a number of industries, including chemicals, pharmaceuticals, health care, food processing, and agriculture. A recent report by the National Academy of Sciences concluded that the Federal Government should play a critical role in expanding the knowledge base in chemical and process engineering. Basic research in this area is complex and the payoff is long-term; hence, it is not undertaken by the many small firms that comprise this industry.

Though biotechnology has its roots in the traditional biological area such as biochemistry and genetics, industrial applications rely also on methods from chemistry, physics, and chemical engineering. The technology is interdisciplinary in nature and requires an understanding of the properties and chemical activity of biomolecules, specialized measurement capability, predictive models, and broad generic data bases -- the same kind of support that NBS has long provided in other areas.

The proposed funding increase will provide research that stimulates the international competitiveness of U.S. chemistry-based industries and promotes more rapid and efficient adoption of improved processes and products by U.S. industries. The Visiting Committee especially supports this increase which presents a real opportunity for NBS to work at scientific frontiers. There are obvious benefits to be gained by anticipating needs rather than struggling to catch up with long overdue demands.

Advanced Ceramics

The fourth initiative of $3.5 million will allow NBS to provide the scientific base, measurement methods, key data, and predictive concepts needed by U.S. industries for the development of reliable advanced ceramics with reproducible and controlled properties. There are a number of high-technology applications for which the unique properties of advanced ceramics are especially well-suited. Because of their resistance to wear, corrosion, and high temperatures and their unusual optical, electrical, and magnetic properties, they are used in many electronics applications, in engines that achieve greater efficiency by operating at higher temperatures, and as cutting tools. Competitive commercialization of these materials is hampered by problems of reliability and reproducability in the production process.

The NBS program involves long-range, fundamental research of a generic nature that complements and supports associated industrial and governmental research efforts. The resulting data, predictive models, measurement methods, and standards will provide U.S. industry with the scientific base and technical support it needs to manufacture high-performance ceramics. The program also will assure the U.S. of a competitive position in the rapidly growing world market where Japan now controls a 50 percent share. This initiative represents another opportunity for NBS to do research at the frontiers of science where measurements and standards can contribute appropriately and significantly to advancing U.S. industry.

Other Budget Concerns

While the Visiting Committee enthusiastically supports all four of the budget increases, we are extremely concerned about several of the proposed decreases. This is the third year in which the Fire and Building Research Programs have been targeted for elimination, yet the Center for Fire Research provides the scientific and technical basis for efforts to reduce the Nation's fire losses and the cost of fire protection. Each year fires result in 7,600 deaths, more than 200,000 severe injuries, and $30 billion in direct and indirect property losses. The Center for Building Technology provides non-proprietary research for the large but disparate U.S. building industry which contributes almost 10 percent of the GNP. Two-thirds of the Nation's wealth is invested in constructed facilities provided by this industry.

In support of the President's drive to cut domestic spending and achieve a significant reduction in the deficit, NBS plans to eliminate the centers for Fire Research and Building Technology. However, the Visiting Committee is concerned that the life-preserving research conducted by these two groups will not be adequately performed elsewhere.

Also, this is the fourth year in which substantial reductions have been proposed to be made in the Institute for Computer Science and Technology. The programs proposed for reduction provide research and development work in standards, information resource management, and computer security -- all serving the needs of both vendors and users. An example of the fine work done by this group is the techniques developed for implementing the computer interface standards successfully demonstrated at the National Computer Conference, which I mentioned earlier.

There have never been any questions or doubts raised regarding the merits of these programs. The justification for these proposed reductions in the past has been based on the assertion that the concerns they address are more properly the domain of state and local governments or the private sector.

In previous years, letters and testimony before this subcommittee have argued that elimination of these programs would be ill-advised. Neither state and local governments nor the private sector have expressed willingness to assume responsibility for continuing work in these three program areas. The Visiting Committee has no information that would indicate that the situation has changed this year. They are sound programs and this work should be continued.

I'd like to point out that in view of the tight budget situation, NBS management has made significant cuts in the general administrative and equipment budgets. NBS management is confident these cuts can be made at no jeopardy to the technical program in the short run. The budget for general administrative functions, such as travel, printing, consulting and overall management, is being reduced by $8.2 million.

The equipment acquisition budget is being reduced by $3.3 million, or approximately 25 percent. The Visiting Committee cautions, especially with regard to the equipment budget, that such reductions cannot be continued from year to year without having an adverse effect on the technical program.

Before concluding I'd like to express our particular concern about the mandated reduction in the number of professionals in Grades GS 11 through GS 15. The effectiveness of all of the programs at NBS is seriously jeopardized by this proposal. Although we understand and even encourage attempts to reduce mid-management bulge, these are the grades occupied by most of the scientists and engineers at NBS. Recent Ph.D level graduates are normally recruited at the GS 11 or GS 12 level.

NBS is implementing this required reduction by replacing only two of every three vacancies arising by attrition in this grade range in the technical areas and none of the vacancies in the administrative and managerial ranks. Promotions from GS 9 to GS 11 have been frozen.

The consequences of this reduction are particularly serious for recruiting new staff with expertise in the special kind of scientific computing that will be done on the new advanced computer facility at NBS. But the restriction is indeed damaging to all the technical programs. It appears that NBS is the victim of a decision made for another purpose. While the intent may have been to reduce middle management, the quality of the technical staff is jeopardized. Relief from this mandate should be given to NBS.

In conclusion, I appreciate this opportunity to state my views and those of the Visiting Committee on these most important matters concerning the budget for the National Bureau of Standards.

UNITED
TECHNOLOGIES

DR. RUSSELL G. MEYERAND, JR.
Vice President-Technology
United Technologies Corporation

Russell G. Meyerand, Jr. was elected vice president-technology for United Technologies Corporation in December 1981.

In this post, Dr. Meyerand is responsible for the corporation's programs in advanced technology. He previously served as vice president-research and development for the corporation, a post he held since 1979. Since 1967, Dr. Meyerand also served as director of research-United Technologies Research Center.

Dr. Meyerand joined the Corporation in 1958 as principal scientist of the plasma physics program of what was then United Aircraft Research Laboratories. He was named the Laboratories' chief research scientist in 1964.

He holds patents for 20 inventions ranging from radar systems to lasers.

Dr. Meyerand is a member of the National Academy of Engineering and a fellow of the American Institute of Aeronautics and Astronautics. He is a senior member of the Institute of Electrical and Electronics Engineers, a member of the American Physical Society and Directors of Industrial Research. He was appointed to the Visiting Committee of the National Bureau of Standards in 1980 and as Chairman during 1984-1985. In 1977, Dr. Meyerand was appointed a member of the Massachusetts Institute of Technology Visiting Committee for the Department of Physics. In 1983 he was appointed a member of the Massachusetts Institute of Technology Visiting Committee for Sponsored Research.

He also serves as a member of the Newington Children's Hospital Board of Directors, the Executive Committee of the Board of Trustees of The Hartford Graduate Center and the Massachusetts Institute of Technology Educational Council.

In 1970, Dr. Meyerand was appointed by the Secretary of the Army to a four-year term as consultant to the Army Scientific Advisory Panel, the senior scientific advisory group to the Department of the Army. He also has served as a member of the National Aeronautics and Space Administration's Space Program Advisory Council.

In 1979, Dr. Meyerand received the Eli Whitney Award from the Connecticut Patent Law Association in recognition of his scientific achievements.

Dr. Meyerand was born in Kirkwood, Missouri. He is a graduate of the Massachusetts Institute of Technology where he received a bachelor of science degree in electrical engineering in 1955, a master's degree in nuclear engineering in 1956 and a doctoral degree in plasma physics in 1959.

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9/84

Mr. Brown. Mr. O'Grady, would you go ahead.

STATEMENT OF JOSEPH O'GRADY, EXECUTIVE VICE PRESIDENT, AMERICAN SOCIETY OF TESTING AND MATERIALS, PHILADELPHIA, PA

Mr. O'Grady. Thank you Mr. Chairman. I would like to begin by indicating for the record that I am here representing William T. Cavanaugh, president of ASTM and chief staff executive, who, for reasons of a bout with the flu, is unable to be with us today.

Mr. Brown. We will forgive him for that.

Mr. O'Grady. I would also like to acknowledge my debt of appreciation to Congressman Ritter for the nice things he had to say about Lehigh University since I have two sons that graduated from Lehigh. I feel very much better that my money was well spent. Thank you.

Mr. Brown. I think Mr. Ritter has this panel a little bit stacked. We only have one Californian and we should have at least two.

Mr. O'Grady. Mr. Chairman, on behalf of ASTM, we feel strongly that the budget that has been announced for fiscal year 1986 needs some very serious reexamination in some areas. Before I get into the specifics of our point of view, it is necessary that I say a few things about ASTM so that the context from which our thoughts emerge will justify our reasons for being here today.

ASTM, formerly known as the American Society for Testing and Materials, is the world's leader in the development of voluntary consensus standards for materials, products, systems, and services. Its 140 standards writing committees publish annually over 7,200 standards to meet the needs of numerous industries, Government agencies, and service organizations. The subjects are diverse and include ferrous and nonferrous metals, waste disposal, construction materials, petroleum, textiles, fire standards, medical devices, and consumer products. Since its formation in 1902, ASTM has expanded to include 29,000 members of whom 4,000 are international. We know from recent studies that there is probably no other organization with a higher degree of credibility and acceptance in the standards world, and it simply could not have happened if it were not for the outstanding cooperative efforts that have existed between ASTM and the National Bureau of Standards for about 85 years.

Both organizations have experienced remarkable growth and both organizations enjoy an excellent working relationship which for both of us has been extraordinarily productive and mutually satisfying.

One of the principle ways that the Bureau moves metrology technology into the so-called private sector is through the participation of its outstanding staff in the work of ASTM technical committees. At the moment there are approximately 280 or so Bureau technologists in the ASTM committee structure and they participate in a very broad spectrum of activities.

The participation of Federal Government employees is vital to the accomplishment of ASTM's mission on behalf of the Nation. This derives from several factors and, notably, that the due process requirements that are a part of the ASTM procedures give general interest representation the same participatory rights—no more, no less—as any other interest group.

Government technical experts typically fit the general interest category of most of these committees and the Congress should know that the Federal technologists are outstanding contributors to the work of ASTM standards committees. This fact is clearly indicated in many ways; the kinds of technologies they bring into the system, their sense of commitment, their sense of dedication, and the fact that so many of them have risen to leadership positions in technical committees, standing committees, and board of director positions at ASTM.

For the record, I have appended a detailed description of some of the kinds of Bureau activities which have met those requirements.

On another subject, ASTM does not take positions on national problems because, like the Bureau, our attitudes toward these national issues need to be and are absolutely neutral. There is one exception. If a public policy issue has the potential to threaten the efficacy of the voluntary standards system of which ASTM is a key part, then, and only then, do we state a position. We believe that the trend in the Bureau budget practices of the past few years is beginning now to constitute to us such a threat.

We do know that there is an understandable desire to transfer certain Government activities to the private sector. We support that policy. But, with all due respect we believe that the organization and mission of the Bureau, especially its neutrality and nonproprietary technology are not transferable to the private sector to any significant degree. It probably should be mentioned that except for the basic metrology standards of the Bureau, that they have handled so well and for so long, there are very few other standards activities, other than certain standards work done by certain Government agencies, most of the standard work is already in the nongovernmental sector which, in our opinion, is where it belongs. In fact, there is, where appropriate, an increasing tendency on the part of Federal agencies, especially in the area of procurement, to substitute nongovernment standards for their own internal agency standards development.

Mr. Chairman, as you might anticipate, ASTM is opposed to the termination of the Center for Building Technology as well as the Center for Fire Research as proposed in the fiscal year 1986 budget. These activities have had, and continue to have, a tremendously positive impact on the work of a great many ASTM committees that has been going on for some time. I respectfully disagree, but disagree I do, with the Bureau's recent press release that research in the Centers for Fire and Building Technology are more properly the role of the private sector and the State and local governments.

Mr. Chairman, the work of the Center for Building Technology and the Center for Fire Research are essential to the development of consensus standards for many ASTM committees. One of the very important reasons is that these facilities be retained is because through the ASTM standards process the participation of those two agencies of the Bureau become an integral part of probably one of the most important regulatory processes in America—I'm referring to the building codes and the life safety codes. I have the impression that when these centers were first rescued from a budgetary point of view last year, they were rescued at the expense of other newer projects under initial development by the Bureau. We also think this is a grave error because there are so many examples of how the Bureau research of today became the consensus standards of tomorrow. Some Bureau activities which deserve to continue for the reasons mentioned include biotechnology, advanced ceramics, and process and quality control measurements. As a matter of fact, there are individuals who are already coming to ASTM asking if it could be possible for committees in ASTM to be started on such areas as biotechnology, which have the potential to enhance and improve the whole issue of how we deal with that critically important area. We are moving forward in that area and the absence of the Bureau in participating in this work would be tragic.

I believe the Bureau's capability to accomplish its mission is being slowly but surely eroded by budgetary constraints. The most invidious aspect of this is that it will take some years before it becomes obvious and it may be too late for adequate repair.

How the Bureau has grown, what it has accomplished over the years, is a matter of public record. It is one institution of the Federal establishment that has national and international respect for technical excellence. Its potential to even better contribute to the technological needs of our Nation should not be undermined.

ASTM respectfully urges that you reconsider the Bureau's budget for fiscal year 1986 and that funding be restored for the Center for Building Technology and the Center for Fire Research without injury to the new activities the Bureau has listed with high priority.

Thank you for this opportunity to be here.

[The prepared statement of Mr. Cavanaugh follows:]

Statement by William T. Cavanaugh

Before the Subcommittee on
Science, Research and Technology
of the Committee on Science and Technology

February 28, 1985

I am William T. Cavanaugh, President of ASTM. The President is the chief staff executive of the organization. ASTM greatly appreciates this opportunity to appear before you to document for the record certain concerns about trends in the budget situation at the National Bureau of Standards. We feel strongly that the budget that has been announced for fiscal year 1986 needs some very serious re-examination in some areas.

Before I get into the specifics of our point of view, it is necessary that I say a few things about ASTM so that the context from which our thoughts emerge will justify our reason for appearing here today.

ASTM, formerly known as the American Society for Testing and Materials, is the world's leader in the development of voluntary consensus standards for materials, products, systems and services. Its 140 standards writing committees publish annually over 7,200 standards to meet the needs of numerous industries, government agencies, and service organizations. The subjects are diverse and include ferrous and nonferrous metals, waste disposal, construction materials, petroleum, textiles, fire standards, medical devices, and consumer products. Since its formation in 1902, ASTM has expanded to include 29,000 members, of whom 4,000 are international. We know from recent studies that there is probably no other organization with a higher degree of credibility and acceptance in the standards world, and it simply could not have happened if it were not for the outstanding cooperative efforts that have existed between ASTM and the National Bureau of Standards for about 85 years.

Early in this century some very smart people in the Congress established the Bureau with its assignment in the area of basic metrology. At about the same time, ASTM was founded to develop standards and related documents to measure and predict the performance of materials in various use situations. Both organizations have experienced remarkable growth over the years. The good working relationship that has developed has been mutually satisfactory and extraordinarily productive.

One of the principle ways that the Bureau of Standards moves metrology technology into the so-called private sector is through the participation of its outstanding staff in the work of ASTM committees. At the moment, there are approximately 279 bureau technologists in ASTM who participate in a broad spectrum of standards activities.

If you measured ASTM by the size of its budget you might not be impressed. ASTM's budget approaches 15 million dollars a year. Almost all of this is derived from the sale of ASTM technical publications worldwide. We do not, therefore, depend in any significant way on contracts, grants, or contributions, etc. to accomplish our purposes. We depend on our pluralistic membership operating in accord with the rules of due process and consensus to produce the publications they need and we sell.

But the ASTM operating budget is merely the tip of the iceberg. At the moment, we have the equivalent of 83,000 people at work in ASTM standards committees. We estimate that the government agencies, industrial organizations, universities and other institutions together spend on their activities upwards of 350 million dollars. Why do they do it? To support a management system for standards development that clearly serves the public interest. It is a system that works well, is largely privately financed, is not dominated by any single interest group, and is one of the best examples of the cooperation between government local, state and federal - and the non-governmental sector working together in pursuit of a mutually shared mission.

The participation of federal government employees is vital to the accomplishment of ASTM's mission on behalf of the nation. This derives from several factors - notably that the due process requirements in ASTM give the general interest representation the same participatory rights, no more-no less, than any other interest group. Government technical experts typically fit the general interest category of most technical committees. The Congress should know that federal technologists are outstanding contributors to the work of ASTM standards committees. That fact is clearly demonstrated by their work, commitment and dedication which have brought so many of them to leadership position in the Society. A more detailed description of typical Bureau activities is appended to this statement. The National Bureau of Standards, quite understandably, has participation significantly larger than any other federal agency. ASTM does not take positions on national problems because, like the Bureau, our attitudes toward these national issues need to be, and are, absolutely neutral. There is one exception. If a public policy issue has the potential to threaten the efficacy of the voluntary standards system, of which ASTM is a key part, then, and only then, do we state a position. We believe the trend in the Bureau budget practices of the past few years is beginning now to constitute such a threat.

We do know that there is an understandable desire to transfer certain government activities to the private sector. We support that policy. But with all due respect to that point of view, we believe that the organization and mission of the Bureau, and especially its neutrality and non-proprietary technology are not transferrable to the private sector to any significant degree. It probably should be mentioned that except for the basic metrology standards the Bureau has handled so well for so long, and except for the standards being developed within other federal agencies in the pursuit of their special missions, most of the standards function in America is already in the non-governmental sector; where, incidentally, it belongs. In fact, there is where appropriate an increasing tendency on the part of the federal agencies, especially in the area of procurement, to substitute non-governmental standards work for their own internal agency standards development.

The Bureau and ASTM for that matter, in our opinion, suffers from two things that we have in common. However important the work of these organizations is, it is to most people obscure and imbedded two or three layers down in the production process. You will rarely, if ever, se anything about these two institutions in the popular media except, of course, when something alledgedly has gone wrong. In short, our activities are part of a larger process in almost all cases and are, therefore, understood as important only by the few who know and understand.

We also have in common that neither the Bureau nor ASTM has had what might be described as a comprehensive unified constituency. The technical scopes of the organizations are so broad that the individual constituents are usually only interested in a small segment of the thousands of activities and for the most part just don't comprehend the "big picture". I guess what all this comes down to is that the Bureau has need of a supportive attitude from your committee and from Congress since it does not seem to be forthcoming on a continuing basis from any other significant source.

As you might anticipate, ASTM is opposed to the termination of the Center for Building Technology as well as the Center for Fire Research as proposed in the FY86 Budget. These activities have had a tremendously positive impact on the work that has been going on in ASTM for many, many years.

I respectfully disagree - but disagree I do - with the Bureau's recent press release "that research in the Center for Building Technology and the Center for Fire Research is more properly the role of the private sector and the state and local governments". Mr. Chairman, the work of the Center for Building Technology and the Center for Fire Research are essential to the development of consensus standards for many, many ASTM committees, and this work becomes an integral part of probably one of the most important regulatory processes in America - Building Codes and Life Safety Codes.

I have the impression that when these centers were rescued from a budgetary point of view last year, they were rescued at the expense of other newer projects under initial development at the Bureau. We think this is a grave error because there are so many examples of how the Bureau research of today became part of the consensus standard of tomorrow. Some Bureau activities which deserve to continue for the reasons mentioned include bio-technology, advanced ceramics, process and quality control measurements. People have already been to ASTM to begin activities in this area which means they are willing to spend of their time and resources in the pursuit of standards technology they agree is badly needed. The value of the National Bureau of Standards' work underpinning the consensus standards process cannot be overstated.

Mr. Chairman, the National Bureau of Standards is the envy of most of the industrialized nations of the world to say nothing of those who are developing nations. Perhaps I should mention that visitors from abroad always want to visit the Bureau to see what it is doing and how it works. They couldn't visit a better place.

I believe the Bureau's capabilities to accomplish its mission are being slowly but surely eroded by budgetary constraints. The most invidious aspect of this is that it will take some years before it becomes obvious and may be too late for adequate repair.

How the Bureau has grown, what it has accomplished over the years, is a matter of public record. It is one institution of the federal establishment that has national and international respect for technical excellence. Its potential to even better contribute to the technological needs of our nation should not be undermined.

We respectfully recommend - we urge - that you reconsider the Bureau's Budget for FY 86, and that funding be restored for the Center for Building Technology and the Center for Fire Research without injury to the new activities the Bureau has listed with high priority.

Thank you for your kind attention, and I am prepared to answer what questions you may have.

Center for Building Technology and Center for Fire Research Work With the American Society for Testing and Materials (ASTM)

The National Bureau of Standards (NBS) has been a major technical contributor to ASTM standards development activities related to measurement technology, test methods, and Special Technical Publications for many years. Central to NBS' mission is developing the technical base for use by voluntary standards developing organizations. Building standards and codes are the primary vehicles for improving building practices and the quality of the built environment. Providing the technical basis for building standards is the major outlet for implementing Center for Building Technology (CBT) and Center for Fire Research (CFR) research results. CBT and CFR contribute much time and effort to ASTM standards committee work. For example, during the 12 months ending June 1984, CBT staff participated in 75 ASTM standards development committees, subcommittees, and working groups, and chaired 11 activities. CFR staff participated in 40 standards development activities and chaired 3. This work represents about 1000 and 350 hours of committee work for CBT and CFR, respectively, and many times these numbers in research time plus substantial expenditures for travel to participate in ASTM standards development work. CBT and CFR committee officer contributions during this time were:

Chair, Thermal Insulation - C16
Chair, Determination of K vs. D Curve - C16.C653
Chair, Nonbituminous Organic Roof Coverup - D08.18
Chair, Terminology in Soil Dynamics - D18.09
Chair, Structural Performance of Horizontal and Vertical Structures - E06.11
Chair, Durability Performance of Building Construction - E06.22
Chair, Materials and Process for Durable Rigidwall Relocation Shelter - E06.53
Chair, Research - E06.95
Chair, Steady State Methods (Absorption) - E33.03J
Chair, Specimen Areas for Second Absorption Measurements - E33.05I
Vice Chair, International Standards - E33.06
Chair, Solar Energy Conversion - E44
Secretary, Thermal Conversion Power Systems - E44.08
Secretary, Fire Standards - E05
Chair, New Concepts for Measuring the E84 Tunnel Test - E05.01A
Chair, Large Scale Test Procedures - E05.02
Chair, Radiant Panel Floor Covering Test Method - E05.09

Other CBT and CFR contributions include:

Chair, Subcommittee on Research of the Cement Committee of ASTM Executive Committee
Chair, Program for 1984 Symposium on Blended Cements
Manage, Cement and Concrete Reference Laboratory (CCRL) Sponsored by ASTM Committee C1 on Cement and C9 on Concrete Aggregates (16 research associates working at CBT)
Division Director, Performance of Building Constructions - E06
Chair, Task Group on Development of Performance-Oriented Standards for Blended Cements
Contributed to numerous ASTM symposia and publications

BIOGRAPHICAL SKETCH

WILLIAM T. CAVANAUGH
PRESIDENT
ASTM

William T. Cavanaugh president of ASTM, is a native of Newark, NJ. He received his B.S. degree magna cum laude from Seton Hall College in 1942.

Cavanaugh became associated with ASTM in 1967 when he was named Director of Field Operations. Three years later, he was appointed chief executive officer of the Society.

In addition to his position as president of ASTM, Cavanaugh serves as a member of the Board of Directors of the National Institute of Building Sciences (NIBS). He served as Chairman of the National Executive Committee of the Consultative Council of NIBS from October 1981 to November 1983. NIBS was created by Congress during the 1970s to encourage a more rational building regulatory environment and to facilitate the introduction of new and existing technology into the building process.

Cavanaugh also serves on the Industry Functional Advisory Committee on Standards sponsored by the U.S. Department of Commerce and the Trade Representatives Office. He was first appointed to this committee in 1980.

In 1976, Cavanaugh was the recipient of the Leo B. Moore Medal from the Standards Engineer Society. He was honored by the American Society Association Executives (ASAE), and granted National Honorary Life Membership by the United States Schools Association for his numerous contributions to the field of association management.

Prior to his association with ASTM, Cavanaugh was Executive Director-Secretary of the Administrative Management Society for seven years. While in that capacity, he restructured the organization, redefined its goals, developed a new fiscal structure, and fostered the professionalism of middle management concept.

Cavanaugh's professional background also encompasses positions as Executive Director-Secretary of the Administrative Management Society, Executive Director of the Engineering Manpower Commission Engineeers Joint Council and Assistant Professor of history, public law, and government at Seton Hall College. He also completed graduate study at the Columbia University School of Public Law and Government.

A commander in the U.S. Naval Reserves, Cavanaugh served during World War II and the Korean conflict.

Cavanaugh currently holds membership in the Council of Engineering and Scientific Society Executives and ASAE. He is also a member of the Board of Directors of the Metal Properties Council, Inc.

JOSEPH G. O'GRADY

BIOGRAPHY

Joseph G. O'Grady, Executive Vice President of ASTM, Philadelphia, PA is a native of North Bergen, New Jersey. He received his B.E.E. Degree from the College of Engineering, New York University, in 1954.

O'Grady joined the ASTM staff in January, 1984. He is responsible for the day to day operations of the Society and coordinating the work of the ASTM managerial staff.

Prior to joining ASTM, he was Vice President of PSE&G Research Corporation, a subsidiary of Public Service Electric and Gas (PSE&G) of New Jersey where he directed the activities of the Research and Testing Laboratory of the company. During that time, he was responsible for the direction of five technical and one non-technical laboratory divisions that performed test work, inspections, and special investigations that were required during the design, construction, and operation of company facilities. In addition, he was responsible for a number of research and development projects, including energy conservation and solar demonstration.

O'Grady was Chairman of the Board of ASTM from 1979-80. He previously served as Treasurer and Vice Chairman of the Society, Chairman of the ASTM Finance Committee, and Chairman of the standing Board Committee on Technical Committee Activities. Joseph O'Grady is Past Chairman of the Codes and Standards Executive Advisory Committee of the Edison Electric Institute and is also a former Director of the American Association for Laboratory Accreditation. He was previously a member of the Environmental Task Force of the Electric Power Research Institute.

O'Grady is presently serving as Chairman of the Annual Planning Committee of the National Executive Committee of the Consultative Council of the National Institute of Building Sciences. He was first elected to the National Executive Committee in October, 1980 and was re-elected for an additional three year term in 1984.

He is a registered professional engineer in the state of New Jersey.

Mr. **Brown**. Thank you, Mr. O'Grady. All of the panelists have delivered excellent statements and the committee is very grateful. I think I'll call on Mr. Ritter first since he has the greatest number of constituents here.

Mr. **Ritter**. Are we including Mr. O'Grady's two sons?

Mr. **O'Grady**. I'm a Philadelphian, by the way, Mr. Ritter.

Mr. **Ritter**. How old are they? Are they there now?

Mr. **O'Grady**. No, they're out. One is about to graduate in June. One is 24 and one is 22.

Mr. **Ritter**. Well, they can't vote in my district anyway.

I appreciate the comments of the panel. I would just like to ask Dr. Humphrey where we're at in this field with respect to the Japanese who do seem to be the major contributor, although the Germans are putting some major investments into this area—major competitor. Let's divide it between the science, the technology and the commercialization. Where are we in this field of biotechnology? Since your interest is in that area of processing, which means making some kind of product, as opposed to simply developing the science base to the field.

Dr. **Humphrey**. Congressman Ritter, I am going to answer this in a very personal way. I'm not sure you are aware that I taught at Tokyo University for 1 year and both of my children went to a Japanese school and I probably educated somewhere around 25 postdoctorate or doctorate students from Japan.

Mr. **Brown**. May I interrupt you to comment that we lost our lead to Japan because of another professor that went over there? I hope you haven't been doing that.

Dr. **Humphrey**. It's a wonderful country. However, one of the things that always amazed me is that they looked to our basic research in science as a kind of nonpolitical string attached aid and they always focused on applied research more than on basic research. When I talk to my former students, they say in the basic science, the United States probably has a 5-year lead on us in biotechnology. That really doesn't worry us because we can read the literature and we're focusing in the applied area, bringing it to commercial fruition.

What is so unusual about Japan is that they have the Koza system in the university and industry can bring their people to the university and they work very closely in small groups. As a consequence, I think there's an infrastructure in Japan that allows them to bring about commercial development of many of these high technologies faster than we can do here in the United States with less financial risk because of this close relationship between the Japanese academic and the Japanese industry.

I would say that we do not have a lead when it comes to the commercialization of biotechnology. There are larger fermenters. The first computer application to a fermenter was done at the Ajinomoto Co. in Japan. In terms of some of the experience that they've had in separating amino acids and enzymes, they have far more experience than any of our companies like Merck, Squibb, or Upjohn have. I think when you disregard the basic science and talk about the commercialization, Japan is neck and neck with us and unless we provide a knowledge base in this bioprocessing, we could very well risk that lead that we have in basic science and simply turn it over to Japan. That's really my concern.

Mr. Ritter. I was in Sakuba where they have a major institute for biotechnology. Do we have a comparable national effort that's Government funded? MITI basically provides the funds for that institute.

Dr. Humphrey. The answer is no. I'm very hopeful that one of these engineering research centers will support a biotechnology center, but no we do not have a comparable biotechnology center. If you're talking about bioprocessing in particular this is true.

Mr. Ritter. The applied, more commercially oriented use of the basic science—I think it's a very important point for all of us on this committee and for the American people, and that is we develop the science base—we have a 5-year lead in the science in this field—and we're neck and neck in the technology and the commercialization. Some people would say that in some areas they're ahead. I think that's a very worrisome trend whereby we win the science race and we lose the commercialization race. In terms of getting a greater—how would you—would you sense we should be creating a national industry oriented institute? Do we get enough out of our academic R&D? Are the National Institutes of Health—is that comparable work or why is it that we're so far ahead in the science and we're just not translating that lead into the technology?

Dr. Humphrey. I think it's a character of the American public where we hold science in such high regard . In the private sector the developing of the knowledge base to support the applied science is the case. Congressman Ritter, Dr. Keyworth had as one of the research briefings this past year, a report on chemical and process engineering for biotechnology. To answer in part your question, I would draw from that report some recommendations. There were basically six recommendations that it said. The first was to establish this fundamental knowledge base. The second recommendation was to provide a funding base at adequate levels for basic research in process engineering. It had suggested that maybe the NIH ought to realize that it has an obligation that goes to basic science in the process area not just to gene splicing. It recommended that there ought to establish some grants for cross-over disciplinary research. The problem in the new biology is that there is a lot of language and new techniques that need to be brought to the attention and we ought to have engineers trained in this field. It was suggested that the Government look into some training grants. Then it said that there ought to be adequate funds to establish centers of biotechnology that focus on the commercialization of these processes.

Mr. Ritter. Are the scientists who are needed to do this standard setting and process work at NBS there now?

Dr. Humphrey. No. One of the problems that we have in the United States is that we have an oversupply of chemical engineers and we have an under supply of chemical engineers that have a basic understanding of the new biology. If you go to these emerging companies—the Genex, CETUS, Genentech, and even to the Monsantos and the DuPonts—they have two or three positions open and unable to fill them with people that can bring together this kind of dual knowledge and understanding. I am hopeful that the

NBS can kind of help fill that gap by providing some of the basic knowledge that is needed here in processing.

Mr. RITTER. Why isn't industry working more closely with universities to promote this kind of talent if there are these gaps?

Dr. HUMPHREY. Industry is just becoming aware that they need to do this. One of the difficulties that I tried to point out is that when you have emerging companies their concern at the present time is to produce a product, to test the product, and to get approval for that product and they're not going to invest in the downstream processing until they have that product. It seems to me that that's our trouble in emerging technology and Government has an important role to play in that they have to help emerging technologies take that initial step.

Mr. RITTER. I'd like to just summarize. This is a generic feature—the application of new technology and part of our gap that we find ourselves big in the science and racing for our lives and, in cases, losing. The fact is that our Government is pulling back from the applied work and is pressing for it to produce that basic research base and leaving the rest to industry. I think it's quite a challenge for this committee to somehow provide the leadership to fill this gap. Thank you for your indulgence.

Mr. WALGREN. The Chair recognizes Mr. Brown.

Mr. BROWN. Thank you, Mr. Chairman. Gentlemen, I think you are all aware that this subcommittee has for years been seeking to achieve a greater emphasis in the area that Mr. Ritter has been talking about through an emphasis on, not only strengthening the Bureau of Standards, but through enhancing support for engineering research which would lead to improvements in process and quality control that this Nation so very badly needs.

We haven't solved that problem yet although there are some indications of progress. We very much appreciate the fact that your testimony supports that kind of effort by this subcommittee, and I hope that this will give it a little bit of motivation to continue in doing that.

Dr. Humphrey, what I was referring to when I interrupted to make the comment, was the contribution that Dr. Demming made to the Japanese in the development of quality control over there. That was not development of new biological or physical research. It was just showing them how to do what we already knew how to do but weren't practicing very well. They seized upon that and achieved the preeminence that they have in high quality, low cost production. I think what you're suggesting is that we prepare ourselves to do that in the biotechnology field and that's the only way we can maintain our leadership in the commercial exploitation of it.

What bothers me about the Bureau of Standards budget is that they have requested and received funds for this new initiative in biotechnology but it's only half as much as they asked for. Can we coast for a year at that level or should this subcommittee be seeking to try and get the amount the Bureau originally thought they needed in order to do this kind of program? Our problem here is trying to use our judgment to determine the real priority of the programs that have been added but not added as much as the Bureau thought they should or which have been cut when the

Bureau didn't think they should be cut. We need your help in making this kind of decision.

Dr. **Humphrey**. I thought the original NBS was for $9 million——

Dr. **Brown**. Maybe that was correct.

Dr. **Humphrey**. Then this is one third of that. There are several aspects too that basic science is concerned with biotechnology. There's the measurements and standards aspect and that very properly is the role of the National Bureau of Standards. There's also the technology on the techniques such as the use of membranes, the use of special absorption techniques, and that is very properly the role of the National Science Foundation and I'm very hopeful that at least one or two of the engineering research centers will focus on biotechnology.

There's also a role that the NIH should be and is not playing. I would hope that your committee might call that to the attention of NIH that they have a role that goes beyond just gene splicing and is really a role in seeing that these processes are adequately understood to bring products that meet the specifications that we need to have in order to put them into human beings.

Mr. **Brown**. That's interesting that you should say that. I think our lead in researching biotechnology is due to the NIH support of fundamental molecular biology now for a generation. To get them to let contracts for research in process engineering seems to me is likely to be a little difficult considering the structure and orientation of that organization. I could be mistaken and I hope I am.

Dr. **Humphrey**. You're absolutely right. The problem is that they spend about $650 million in basic research and gene splicing and there's less than, in all of the agencies, $6 million spent in this applied science or applied bioprocessing science. It's unbalanced and I think NIH could spend a little more.

Mr. **Brown**. May I explain this sudden departure here. There's a vote on that that lasts 15 minutes. The chairman's gone over to vote and I'm supposed to entertain you for a few minutes. Getting back to the fundamental priority questions that I raised, you all know that we face a stringent budgetary year, and every agency is being asked to reduce its expenditures in whatever way that it can. It leaves the Congress in a very difficult position in trying to sort these things out. Normally we would be reluctant to go beyond what the administration is asking for in a situation like this, but we don't have to agree and frequently do disagree with the administration with regard to priority. However, we need to be reasonably certain that our priorities are just as good or better than those which are submitted to us by the OMB. We're looking for that kind of guidance. With regard to the elimination of the Fire and Building Programs and the 50-percent cut in the Computer Program, we're very much concerned whether those are important enough to put back in or not. All of you testified in support of those. I don't suppose you would testify that they were important enough to reduce something else in the budget. We merely ought to restore additional funds to take care of that. Am I correct?

Dr. **Meyerand**. I think Mr. O'Grady said it very well when he said the Center for Building Research and Fire Research was particularly important to justify its own funding without sacrificing some of the other new initiatives such as biotechnology and others that are ongoing. That would be my position too, sir. In the area of computer science, I think that's particularly important as well. We all know that we're in very serious competition in the areas of automation and automotive manufacturing by the Japanese once again. One of the difficulties in achieving that in this country has been the lack of interface standards between various computers and numerical controlled machine tools. The Bureau has taken a very leading role in this area and has developed standards which will make the U.S. equipment in the area of robotics much more efficient and effective and much more competitive in the world marketplace.

Mr. BROWN. Will you please elaborate a little bit on this question of reducing the numbers of the GS 11's to 15's in the Bureau. How significant would that action be in terms of the ability of the Bureau to continue to fulfill its mission effectively if it's allowed to stand? Would we be justified in seeking to eliminate that provision in the administration's proposal?

Dr. MEYERAND. I think it would be extremely important to do so. The GS 11 to 15 is the area of the core technical staff of the Bureau. I pointed out that there would be no increases in the administrative and managerial areas of GS 11 to 15 which is the Federal Governmentwide thrust to reduce the number of persons in the middle management bulge. Persons with advanced training are in that salary range and if they're not recruited by the grades of GS 11 through 15, they will go elsewhere to private industry. I think this is a very serious matter because it affects the very thrust of the most productive and effective technical persons on the Bureau staff.

Mr. BROWN. We're going to have to search for ways to do some creative financing here. As all of you know, the Bureau does receive a very substantial amount of funding from external sources, both private industry and other governmental units.

Is there a possibility that the ASTM might want to pick up some of the budget for fire and building research?

Mr. O'GRADY. Mr. Chairman, I'm very pleased to tell you that in a small way this year we plan to support general-interest participants, but to pick up a major portion of your budget for an organization whose annual budget is $15 million would not be possible.

Mr. BROWN. You have such a tremendous base behind it.

Mr. O'GRADY. Yes, sir, we do indeed. There's an enormous number of people by virtue of the constituency that come into ASTM that probably collectively will spend by their time and their resources in the standards development process more than $350 million per year. We know that. What we have done for our budget this year is to recognize that the funding that we were using to pay for consumer participation in ASTM activities should be expanded to include some forms of general interest participation which may very well mean that there will be some funding available from ASTM to finance travel and other expenses for some Bureau people who will be working in the ASTM system.

Dr. MEYERAND. Mr. Brown, if I might add to that, I think the Bureau is doing a very fine job in actually having persons from the outside community work at little or no cost to the Government.

Just this year there were 153 industrial research associates and 523 guest workers in residence at the Bureau right now carrying out work of crucial interest to this country.

Mr. BROWN. Did you get an estimate or an approximation of the dollar value of that donated work when you were making your visits?

Dr. MEYERAND. Only a very rough one. If you feel that a researcher is a budget of about $100,000 a year that would be perhaps the order of several tens of millions. It's a very substantial number. It is not the major portion of the Bureau's budget, but it certainly is tens of millions.

Mr. BROWN. If I don't leave right now I'm going to miss that rollcall, so I'm going to recess for 2 or 3 minutes. I think Mr. Walgren will be back by that time.

[Recess taken.]

Mr. WALGREN. Could I ask us to reassemble. I would like to recognize Mr. Boehlert for questioning.

Mr. BOEHLERT. Mr. O'Grady, if I may, I took down a note and I want you to know that we, too, respectfully disagree with the administration's budget proposal to zero out the Center for Fire Research and the Center for Building Technology.

We're always told by the administration that we should do that because now the time is right. We do away with a Federal expenditure and we will be shifting the responsibility where we should, and the private sector will pick it up. Is there indication that you might give us to support the administration's position or refute it.

Mr. O'GRADY. As a person who is part of a staff organization, as I said in my opening remarks, ASTM must, because of the nature of its activities be silent and completely neutral. Only in those cases where we see a threat to the efficacy of our system are we even permitted to speak because ASTM is a not-for-profit organization.

Mr. BOEHLERT. So you're not capable of lobbying and feel very strongly about this?

Mr. O'GRADY. We feel very strongly about this issue and I think this committee will be hearing from others that for example, with respect to the Center for Building Technology. The United States would be the only developed country in the world without an integrated interdisciplinary national building research laboratory. It would lose its only integrated nonproprietary program aimed at removing technological market place barriers, And it would be unable to carry out its key assigned role in the National Earthquake Hazards Act. These are some of the consequences of the discontinuance of that activity from the ASTM perspective. It will also deny the ASTM system the technology, the expertise of the NBS, and the development of consensus standards that will eventually find their way into building codes and life safety codes.

We are very concerned that the disbandment of such an activity could create long-term future problems in the area of the construction industry and the preservation of life from the ravages of fire.

Mr. BOEHLERT. I wasn't setting you up, honest, but that's the answer I thought I would get. Just so you can sleep a little more comfortably this evening, I think you're going to find on both sides of the Chair sympathy for that position.

Dr. Meyerand, I would like to ask you—I am concerned as you are—you brought out in your testimony something I think needs to be focused on talking about National Bureau of Standards freezing people in certain grade levels. You are also aware that this budget calls for a 5 percent reduction for all these people. I wonder if there's any incentive at all for any technical people with a high degree of competence to even think of serving in the Federal Government. I am really disturbed by the budget proposals in this regard. I think we have to keep the talented people you and I both recognize we have. I thank you for focusing attention on that and I hope you will continue to preach the gospel far and wide because it's an area of great concern.

Dr. MEYERAND. It truly is and the visiting committee is unanimous in this position.

Mr. BOEHLERT. Thank you very much and I thank all of you for the expert testimony. No further questions, Mr. Chairman.

Mr. WALGREN. Thank you. Let me on behalf of the subcommittee express our appreciation for what you've put together here. It serves as a good base for our evaluating what has been proposed.

The next panel consisting of Mr. John A. Gosden, vice president, Equitable Life Assurance Society; Mr. William Connolly, president, National Conference of States on Building Codes and Standards; and Mr. Thomas Moses, chairman of the Board, National Institute of Building Sciences will please come forward.

Welcome to the committee. As has been said, your written statements will be made part of the record and if you will feel free to summarize or otherwise outline the points that you feel are most important to communicate to the committee, it will certainly be appreciated. Let me ask you to proceed in the order in which you were called. Mr. Gosden.

STATEMENT OF JOHN A. GOSDEN, VICE PRESIDENT, EQUITABLE LIFE ASSURANCE SOCIETY, NEW YORK, NY

Mr. GOSDEN. Good afternoon, Mr. Chairman. Thank you for inviting me to speak today on behalf of the Computer Institute. I just wish to make a few brief points which are more fully documented in my written statement.

I'd like to begin by saying just a few words about my credentials. I've been for 6 years on the evaluation panel for the Computer Institute. I've been in the computer industry since 1953, both in England and the United States, as a developer, a consultant, and a user, including work on large military systems. For the last 15 years, I've been with a large financial institution in New York. I've been continually involved in standards at all levels, in corporations at both the national and international level. I have within my current responsibility policies, strategy, standards, and guidelines for technology at Equitable Life. I believe that this is experience that is very relevant to the role of ICST today, both in the Government and for the Nation.

I want to address two major roles of the Computer Institute. First is its role as an advisor to the Government, and second is its role in support of international standards that help maintain our international competitive position.

First, as advisor to the Federal Government on the use of computers and communications: The pace has changed today and this technology is accelerating. We've always thought it was going to slow down, and it seems to get faster and faster every year, especially with the introduction of microcomputers in recent years. There is a huge variety of choices. Users need expert guidance on what to do. Just to read the popular press requires a major allocation of time each week. The payoff for guidance is very large. The institute commissions studies on technological guidance, and the payoff can be very high in making good choices and saving a lot of duplication.

Most large organizations fund this sort of guidance function for their own use, and it's used considerably. I run this kind of function at the Equitable. We've had it for many years. It's hard to believe the Government would reduce the funding for such a thing at this time. An ounce of planning is worth pounds of later worry and trouble, and this is a very high payoff area. Even the Grace Commission didn't recommend any cuts in this area. I consider that to be an amazing accolade. If it is formally cut out of the budget, it's going to reappear in multitudinous ways; small private advisory groups will appear all over the place. The last thing I can say about it is that it's a success in place. Not only do people within all parts of the Government come to the institute for advice and use their standards and guidelines, but this also applies to industry. People turn up in droves to institute seminars and write in for institute documents.

I wish to make one more point to support that, and that is the importance of the competence funding that also is in their budget, which they use to keep their people up to date. It is one of the attractions that keeps some of the people at these places in spite of the risk every year of losing their jobs and not being recognized.

Let me move on to their role in the standards activity which I think is crucial to the U.S. position in international markets today, particularly for the microcomputer revolution. Here again, this country has built up a huge lead in this area, not only in basic research, but also in the marketplace. The problem here is to exploit that at the international level. The name of the game in the international arena is standards. I think this has been discussed before, and I've elaborated on it in my document. The entrepreneur who has just grown up in business and has launched his product and is racing along to capture the American market hasn't even thought about the standards commission down the road. The preparation that needs to go into that is certainly not taught in our business schools as part of what you need to know as an entrepreneur.

ICST has been very effective in this international standards area. It's got a position of impartiality which enables it to represent a wide spectrum of American positions. Quite often what we will see happening is that the Europeans will in fact start to set up a standard that is incompatible with a successful U.S. product but that doesn't yet have a competitor in Europe. In essence, this forces the American manufacturer to live with two different standards or find some way to resolve this problem.

International standards are competitive situations. If you pass this issue over to private industry, I don't think they will really quite know what to do with it. In theory, private industry has the skills and the right kind of people, but in practice they're not organized to do this kind of thing. I think this is an area where the Nation as a whole needs to get its act together to protect itself in the international market.

I guess my remarks in this area would be very easily summarized in a trite but true phrase: If it works, don't fix it; if it works well, encourage it. I would like to call the current budget allocation frugal. My concern is that it's parsimonious and has gone beyond frugality. Thank you very much.

[The prepared statement of Mr. Gosden follows:]

STATEMENT OF JOHN A. GOSDEN
VICE PRESIDENT AND TECHNOLOGY OFFICER
EQUITABLE LIFE ASSURANCE SOCIETY
OF THE UNITED STATES

BEFORE THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
HEARINGS ON FY 1986 AUTHORIZATION
OF NATIONAL BUREAU OF STANDARDS

FEBRUARY 28, 1985

Mr. Chairman and Members of the Subcommittee:

Thank you for inviting me to speak to you today on the program and funding of the Institute for Computer Sciences and Technology (ICST) at the National Bureau of Standards. As you know, I have served on the ICST Evaluation Panel for the last six years, and thus have been in a position to follow and review the Institute's activities and products. My career in computing and communications began in 1953 and I have been involved in the development and use of technology in government (including major defense systems) and industry (particularly financial services). Currently I am concerned with setting technology policy and strategy to assist my company in exploiting technology to meet its business goals. In addition, I have been involved in the development of corporate, national, and international computer technology standards throughout my career and so have first-hand knowledge of the technical and political challenges which face ICST in that area.

Let me say at the outset that at Equitable I carry out a role in many ways similar to ICST and just as that role is recognized to be essential and cost effective for the Equitable, so is ICST essential and cost-effective for the government.

In my testimony, I would first like to review the ICST charter, and then describe ICST efforts in the half of the program that the Director of ICST did not address in his written testimony -- those areas which would be eliminated by the proposed budget cut.

As you recall, the ICST program was established in 1965 under Public Law 89-306, called the "Brooks Act." This law called for the establishment of an organization within the Department of Commerce to (1) develop needed Federal ADP standards, (2) give technical guidance to government agencies, and (3) perform necessary research. The continuing need for this program was recognized by Public Law 96-511, the "Paperwork Reduction Act," which called for the "revitalization" of the standards program. It should be noted that the Institute has been proposed for funding reductions every year since passage of that Act.

The two key roles of the Institute for Computer Sciences and Technology are to be:

- an advisor to government users on new technology, and
- a developer of standards in the user and international arena.

Most large corporations have set up similar organizations to provide guidelines and standards for the use of computers and communications technology. They are seen to be essential and effective cost savers and productivity improvers. The benefits are obvious to industry and it is hard to believe that the modest level of effort at ICST is to be reduced in this increasingly complex environment. The pace of new technology is so fast that this kind of help is essential. Indeed, if central help is eliminated, it will spring up in multitudinous places at greater expense and less effectiveness.

I strongly recommend continuation of ICST funding required to fulfillthis role, and the technical research needed to support it, as a money-saving investment with a high rate of return.

ICST has published many standards and guidelines and these are widely used. The quality and value of this work is evidenced by the extent to which private industry uses these products. To do this work well, ICST must also carry out a minimal level of activity to maintain and extend its expertise, whether by research or experiments.

In addition to the work in computer network protocols, which was described earlier this week, the current ICST program addresses other areas of major national concern including computer security, software development and maintenance, database management technology, and computer graphics. I will highlight selected activities in each of these areas. These are important and critical topics, not esoteric exercises.

ICST has been a leader in the field of computer security and risk management for over a decade. Its technical reports, guidelines, standards, and workshops provide urgently needed help in protecting valuable computer systems and data from accidents and other threats including computer "hackers" and terrorists. In addition, ICST has been actively working with industry and Federal auditors and computer security professionals to transfer information on new and emerging solutions to problems in this area. As the only non-Defense agency with a program addressing overall computer security issues, ICST is also an effective agent for the transfer of security technology developed for defense applications to civilian government and the private sector. Recently ICST produced an especially timely report addressing the increased vulnerability of data due to rapidly growing use of microcomputers.

ICST-commissioned cost-benefit studies estimate over $600 million in expected benefits from a portion of ICST's products. Of these, nearly $300 million are associated with software standards which are just now beginning to emerge. Most of these benefits will accrue from a need for fewer personnel and lower expenditures for training. With personnel costs totalling over 20% of the estimated $14 billion in FY1985 Federal information technology expenditures, ICST software standards can be a significant factor in containing Federal costs in this area.

ICST has been a leader in the development of computer programming language standards for twenty years. Such standards make it possible for software to be moved more easily between computer systems and reduce programmer training costs. Standards now exist for languages used in scientific applications, business applications, microcomputer applications and embedded, high performance systems. In addition to supporting the development of such language standards, ICST developed guidance on choosing the appropriate language for the job.

The major programming language in government and business data processing is called COBOL. For the past few years, this language has been undergoing much needed revision. ICST has been a leader throughout the development and revision of COBOL. In addition it provides leadership to the international standards committee for COBOL to help insure the consistency of U.S. and international standards. Based upon a rigorous analysis of over one million lines of Federal COBOL programs, ICST estimates net savings to the government of $76 million resulting from adoption of the proposed COBOL revision.

Another example of the ICST contribution in software standards is the work on data dictionary systems. A data dictionary system is a powerful software tool used to manage information resources. Specifications for this class of software were developed by ICST in collaboration with groups from private industry, academia, and the Federal government, and have now been accepted by the American National Standards Institute as a basis for U.S. and international standardization. These specifications enable computer users to define the essential features and functions required for data dictionary systems. With proper use, such tools can improve information exchange and control data duplication while enhancing information integrity. The expected cost savings from this proposed standard exceed $130 million.

The emergence of computer graphics as an invaluable tool for conveying technical information, technical training, and general communication of information is well known. Now, as graphics technology becomes ubiquitous on mainframe and microcomputer, the demand has grown for graphics-based systems that are much easier for programmers and non-technical personnel to use. Emerging standards in this field promise benefits including portability of graphics software and reduced training costs. ICST is actively participating in the development of these national and international graphics standards and techniques for testing the conformance of products against these standards. In recognition of this role, ICST was recently asked to serve as the international registrar for all products conforming to a major, new graphics software standard.

Another factor that argues for the continuation of funding to ICST is the widely recognized "explosion" of microcomputers throughout organizations. While this technology promises vast opportunities for productivity improvement, it is accompanied by an explosion in the problems that led to the original demands for computer technology standards -- non-portable software, increasing training costs, microcomputers that are unable to communicate with those made by a different vendor, increased exposure of data to misuse -- the list goes on and on. Indeed, we now have a whole new set of interface standards and protocols to worry about, and they occur as a user, not a technologist, level. This raises new, more critical and more difficult issues. Within Equitable, as in other large corporations, we have recognized the critical need for prompt guidelines and strategies for acquiring and using microcomputer technology. ICST has already begun to produce guidance on selecting and managing micros, aimed at Federal users.

Now I want to speak to the more complex topic of the United States role and position in international trade. This is where the technology battle is to be fought. I want to contrast the issues of technology innovation and consolidation.

The free and aggressive marketplace in the United States has given us an advantage in technological innovation. But that same environment puts us at a disadvantage when we try to consolidate our position in the international markets where standards can operate against us, in effect, as trade barriers. Fortunately, the Institute has been a major catalyst and focus for our success in the international standards arena.

First, let me address technology innovation. In the field of computing and communications, the United States has built and enjoyed a huge lead. This is especially true with the microcomputer revolution. This has not been done by the large corporations. This has been done by small, highly creative, extrepreneurial companies, who have flourished in an environment that has allowed literally millions of ideas to be tried,and the few good ones to have spectacular success. In this free marketplace, innovation has flourished and central organization and control are inefficient.

But when we consider the consolidation of initial commercial success, we find that standards, *de jure* or *de facto*, play a dominant part.

In the United States most users have a huge variety of choices, but in most cases, they select whatever it is that most others have picked: "surely, it must be a safe choice." Someone gets a lead in the marketplace, based on timing, need, price, availability, luck or effectivness; and then that lead increases as one major product tends to dominate each market niche. COBOL, SNA, the 80-column punched card, Lotus 1-2-3, WordStar, and Mark IV, are all robust survivors of this environment. Thus in our national marketplace, de facto standards lock in successful products that emerge from the free marketplace--products, in effect, selected by the leading edge users.

This is fair and reasonable in the United States, but the rules are different in the international arena. In that arena, standards are set more de jure than de facto and are conditioned more by national interests than market success as in the United States. In effect, international standards can be trade barriers.

If we want to consolidate, rather than dissipate, our computer success in the international market, we need a strong, technical presence at the international standards table.

ICST has demonstrated that it is uniquely situated and qualified to be an effective, impartial negotiator among vendors, users, and representatives of other countries across all areas addressed by its program.

This is a key role that the Institute for Computer Sciences and Technology has played effectively.

In summary, ICST is a critical national resource for the development of vital, urgently needed Federal, national and international standards. On that basis alone, I feel that no prudent businessman who understood the trade-offs would support the proposed budget reduction. I hope that these examples demonstrate the the effectiveness and breadth of this valuable program. It is clearly a program that pays for itself many times over. While I generally support efforts to reduce the Federal budget, it seems common sense that one doesn't cut a program whose products boast a return on investment of over 25 to 1.

This is the fourth consecutive year that a drastic funding cut has been proposed for ICST. Except for a 15% cut in FY1983, Congress has restored the proposed reductions, recognizing that no other organization can adequately provide these critically needed services. I urge you to support restoration of the proposed cuts to the ICST FY1986 budget. An expenditure of $10 million to more effectively utilize $14 billion in Federal information technology expenditures would be money well spent even if we ignore the benefits to the private sector.

Thank you. I would be happy to answer any questions you might have.

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BIOGRAPHY

JOHN A. GOSDEN

Mr. Gosden is a Vice President and the Technology Officer of the Equitable Life Assurance Society, responsible for technology policy, strategy, innovation, research, and executive information services.

He joined Equitable in 1970 as a Second Vice President in charge of the Technical Support Group and was responsible for EDP technical planning, development, maintenance and training services for computer operations and programming. From 1971 to 1975 he was in charge of implementing and running CAPS, a large scale on-line system to run the individual insurance business. From 1975 to 1978 he was in charge of Corporate Computer Services, providing computing and systems development services to Equitable, was responsible for effective use of computers, chaired the EDP Policy Committee, and was responsible for institutional policy, standards, and systems assurance. From 1978 to 1980 he was responsible for planning, providing and recommending management policy for all electronic communications both voice and data. From 1980 to 1981 he was in the Financial Management Office where he was responsible for the implementation of a new financial information system.

Previously Mr. Gosden was a Department Head at Mitre Corporation (1976-9), a member of the technical staff at Auerbach Corporation (1961-6), and at Leo Computers Ltd. (1953-60).

In 1977 Mr. Gosden was chairman of a Federal Advisory Group on White House Information Systems advising Frank Press, Science Advisor, and Richard Harden, Special Assistant to the President, on ways to use information systems to improve the decision making processes of the President. Earlier he participated in special review groups on: the National Library of Medicine MEDLARS system; the U.S. Air Force Manned Orbiting Laboratory system; the Air Traffic Control En Route system; and the Internal Revenue Service systems.

Mr. Gosden is: a Fellow of the British Computer Society; member and past chairman of the AFIPS (American Federation of Information Processing Societies) Governmental Activities Committee; a member of a Visiting committee at Harvard; a member of a National Academy of Sciences review committee for the Computer Institute at the National Bureau of Standards; a Trustee of EDUCOM; and a member (and former chairman) of the ACM Publications Board. He was appointed a national lecturer and visiting scientist by the ACM in 1964, 1967, 1972, and 1974.

Mr. Gosden was a Foundation Scholar at Monmouth School, and a Scholar at Cambridge University where he gained a BA and MA in Mathematics.

Mr. **Walgren**. Thank you, Mr. Gosden. Mr. Connolly.

STATEMENT OF WILLIAM C. CONNOLLY, PRESIDENT, NATIONAL CONFERENCE OF STATES ON BUILDING CODES AND STANDARDS, DIRECTOR, DIVISION OF HOUSING, TRENTON, NJ

Mr. **Connolly**. Thank you, Mr. Chairman and members of the subcommittee, for inviting me to testify here today on the matter of continued funding for the National Bureau of Standards valuable centers, the Center for Building Technology and the Center for Fire Research.

The organization which I represent, the National Conference of the States on Building Codes and Standards was founded nearly 20 years ago to coordinate on a national basis the building code and public safety interest of the 50 States. The conference today is an executive branch or organization with a formal agreement of cooperation with the National Governors' Association.

My appearance before you today as the conference's 1984 president marks the fourth time in the past 2 years that our organization has provided written or oral testimony before a congressional committee in opposition to the proposed zero budgeting for the Centers for Building Technology and Fire Research. In written testimony submitted to this subcommittee last year our executive director described in detail some of the irreplaceable building technology and fire safety research which these two centers provide to our States. In that testimony we noted that it is clearly in the national interest and well within the scope of the New Federalism to continue these kinds of activities at the Federal level. Were it otherwise, we would have a chaotic and unproductive research system in which each State could find resources for testing and research and quite probably would duplicate research being done in other States. This would clearly be a waste of the taxpayer's dollars.

This position was later substantiated by the conference in the results of a detailed survey of each of the States past, present, and future building technology and fire safety research needs. That survey clearly showed that of the 30 States responding, only 2 States funded research of any kind in the building regulatory or fire safety regulatory area. When asked which areas they would conduct studies in if they had the funds, nearly every State put forward an almost identical list of building and fire safety research items which included fire toxicity, indoor air quality, and structural failures. The results of that spring 1984 survey were shared with the members of the Senate Subcommittee on Science, Technology, and Space and our subsequent testimony on the fiscal year 1985 funding for the National Bureau of Standards.

For the record, Mr. Chairman, we have included a copy of that 1984 survey and Mr. Wolfe's presentation before the Senate committee in the written testimony that we have submitted here today.

While the Governors of our many States have been vocal in their support for the Congress' efforts to find ways of reducing the Federal deficit, the conference adamantly maintains, as it has for the past 9 years, that the elimination of approximately $9 million of combined Federal funding for the two centers in question here is neither a prudent nor a practical place to begin to achieve a portion of the Federal budgetary savings which we all desire.

Between 1984 and the present, nothing has changed to diminish the urgent need for continued funding for these two vital Federal public safety research programs. No State or group of State and local governments have obtained substantial funding or developed comparable technical research facilities or staff.

Indeed, the events of the past year have only further clarified the continued need for the work of these two centers.

I would like to close my testimony before you this afternoon by highlighting three such events. Last April, the conference testified before the House Subcommittee on Investigations and Oversight on the importance of State and local governments having access to the expertise of the National Bureau of Standards in investigating significant structural failures in public buildings. In that testimony we described an effort that was being initiated among the conference, the National Bureau of Standards, the Association of Major City Building Officials, and the American Society of Civil Engineers to draft model agreements between the National Bureau of Standards and State and local jurisdictions which could be immediately enacted and put in place should a building failure occur.

Under such agreements, the Bureau would then be invited into the disaster site with full legal authority of the city or State behind it to study and report on the probable cause of the building failure. That task force, funded jointly by the Bureau and its three other member organizations, has prepared a preliminary draft model agreement, a copy of which is also enclosed with our written testimony. Next month, this task force will meet here in Washington, DC, to prepare a revised final draft which will be subsequently made available to State and local jurisdictions throughout the country.

We would invite any member of the committee who had an interest or any member of the committee staff to attend the meeting where those agreements are finalized later in March.

As we noted before Congressman Gore's subcommittee last spring, the structural failure expertise of the Center for Building Technology has proven to be an effective force in helping prevent future structural failures.

A second area of vital importance to the States has been the Bureau's continued dissemination to State building and fire officials and the building codes and standards community the results of research into fire toxicity, smoke control, indoor air quality, energy conservation, and structural integrity of building materials. This past September in Denver, CO, our conference and the National Bureau of Standards cosponsored the Sixth Joint Technical Conference on Research and Innovation in the building regulatory process. As a followup, the conference this month will be sending out its biannual survey to the States' building codes departments to ascertain their building technology, fire research needs. As we have previously testified to this committee, the results of these State research surveys are shared with the Bureau under our agreement of cooperation and are used to help the Bureau prepare its annual research agenda.

Third, in July of this year the National Bureau of Standards and the National Fire Protection Association will hold the National Fire Research Strategy Conference, which will provide national direction and coordinate future public and private research in the area of fire safety. We are actively encouraging the States to participate in that effort.

These efforts and model investigation agreements, dissemination of safety information, the national coordination of research on building technology and fire safety are clear examples of the vital work which only the National Bureau of Standards can provide on behalf of the American public. As our delegate from the State of Illinois put it last year in responding to our survey:

> The need for the type of research that both of these centers provides should be obvious. Unnecessary loss of life will continue to occur if the research is not performed. Duplication of this same research in each of the 50 States would certainly be sinful.

On behalf of the National Conference of the States on Building Codes and Standards, its members and States, I respectfully request that your subcommittee take the necessary steps to continue to adequately fund both the Center for Building Technology and the Center for Fire Research. These centers must be allowed to continue their valuable research and information dissemination which enhances the health and the life safety of the citizens of all our States and territories.

I thank you again, Congressman Walgren and members of the subcommittee, and I would be pleased to answer and respond to any questions you might have.

[The prepared statement of Mr. Connolly follows:]

BEFORE THE
U. S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
OF THE
COMMITTEE ON SCIENCE AND TECHNOLOGY

IN THE MATTER OF:

FISCAL YEAR 1986 BUDGET PROPOSAL)
FUNDING FOR THE NATIONAL BUREAU)
OF STANDARDS' CENTER FOR)
BUILDING) TECHNOLOGY AND CENTER)
FOR FIRE RESEARCH)

WRITTEN TESTIMONY
OF THE
NATIONAL CONFERENCE OF STATES ON
BUILDING CODES AND STANDARDS, INC.

FEBRUARY 28, 1985

BY: WILLIAM M. CONNOLLY, PRESIDENT
NATIONAL CONFERENCE OF STATES ON
BUILDING CODES AND STANDARDS, INC.
481 CARLISLE DRIVE
HERNDON, VIRGINIA 22070

BEFORE THE
U. S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
OF THE
COMMITTEE ON SCIENCE AND TECHNOLOGY

IN THE MATTER OF:

FISCAL YEAR 1986 BUDGET PROPOSAL)
FUNDING FOR THE NATIONAL BUREAU)
OF STANDARDS' CENTER FOR)
BUILDING TECHNOLOGY AND CENTER)
FOR FIRE RESEARCH)

SUMMARY
WRITTEN TESTIMONY
OF THE
NATIONAL CONFERENCE OF STATES ON
BUILDING CODES AND STANDARDS, INC.

REGARDING THE PROPOSED FISCAL YEAR 1986 ZERO FUNDING FOR THE NATIONAL BUREAU OF STANDARDS' CENTER FOR BUILDING TECHNOLOGY AND CENTER FOR FIRE RESEARCH, THE NATIONAL CONFERENCE OF STATES ON BUILDING CODES AND STANDARDS, INC. (NCSBCS) FINDS:

1) THE NATIONAL BUREAU OF STANDARDS' CENTER FOR BUILDING TECHNOLOGY AND CENTER FOR FIRE RESEARCH CONTINUE TO PROVIDE THE NATION'S STATES AND LOCAL GOVERNMENTS WITH INVALUABLE BUILDING AND TECHNOLOGICAL RESEARCH WHICH THE

STATE AND LOCAL GOVERNMENTS DEPEND UPON TO HELP THEM ADOPT AND ENFORCE MODERN BUILDING AND FIRE CODES WHICH PROVIDE FOR THEIR PUBLIC'S HEALTH AND LIFE SAFETY IN NEW AND EXISTING BUILDINGS.

2. THAT THE STATES INDIVIDUALLY OR WORKING TOGETHER CANNOT AND WILL NOT BE ABLE TO BUILD, STAFF, AND FUND OR CONTRACT FOR SUCH RESEARCH SHOULD THE CENTERS FOR BUILDING TECHNOLOGY AND FIRE RESEARCH CEASE TO OPERATE.

3. THAT EVEN IF THE STATES WERE ABLE TO BUILD, STAFF, AND FUND OR CONTRACT FOR SUCH RESEARCH, THAT EACH STATE WOULD DUPLICATE THE RESEARCH PROGRAMS OF THE OTHER STATES IN THE AREA OF BUILDING AND FIRE SAFETY, RESULTING IN A LARGE AND INEXCUSABLE WASTE OF TAXPAYERS' FUNDS.

BASED UPON THESE FINDINGS, NCSBCS CONCLUDES:

THAT THE CENTRALIZATION OF RESEARCH IN BUILDING TECHNOLOGY AND FIRE SAFETY AT THE FEDERAL LEVEL REMAINS A PROPER AND FISCALLY RESPONSIBLE ROLE FOR THE FEDERAL GOVERNMENT AND AS SUCH, THE NATIONAL BUREAU OF STANDARDS' CENTER FOR BUILDING TECHNOLOGY AND CENTER FOR FIRE RESEARCH SHOULD CONTINUE TO BE FUNDED AS THEY HAVE BEEN IN RECENT YEARS.

BEFORE THE
U. S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
OF THE
COMMITTEE ON SCIENCE AND TECHNOLOGY

IN THE MATTER OF:

FISCAL YEAR 1986 BUDGET PROPOSAL)
FUNDING FOR THE NATIONAL BUREAU)
OF STANDARDS' CENTER FOR)
BUILDING) TECHNOLOGY AND CENTER)
FOR FIRE RESEARCH)

WRITTEN TESTIMONY
OF THE
NATIONAL CONFERENCE OF STATES ON BUILDING CODES AND STANDARDS, INC.

ON BEHALF OF THE BOARD OF DIRECTORS AND MEMBER STATES OF THE NATIONAL CONFERENCE OF STATES ON BUILDING CODES AND STANDARDS, INC. (NCSBCS), I WANT TO THANK CONGRESSMAN WALGREN AND THE MEMBERS OF THIS SUBCOMMITTEE FOR EXTENDING TO US AN INVITATION TO TESTIFY BEFORE YOU ON THE ISSUE OF THE FUTURE FUNDING OF THE NATIONAL BUREAU OF STANDARDS' CENTERS FOR BUILDING TECHNOLOGY AND FIRE RESEARCH.

THE NATIONAL CONFERENCE OF STATES ON BUILDING CODES AND STANDARDS IS AN EXECUTIVE BRANCH ORGANIZATION OF THE NATIONAL GOVERNORS' ASSOCIATION. NCSBCS WAS FOUNDED IN 1967 TO NATIONALLY COORDINATE THE BUILDING CODE AND PUBLIC SAFETY INTERESTS OF OUR NATION'S FIFTY STATES AND SEVERAL TERRITORIES. OUR VOTING MEMBERSHIP IS COMPRISED OF ONE GOVERNOR-APPOINTED DELEGATE FROM EACH STATE AND TERRITORY. THESE DELEGATES, FOR THE MOST PART, HAVE THE BROADEST RANGE OF RESPONSIBILITY IN THEIR STATE FOR HEALTH AND LIFE SAFETY IN NEW AND EXISTING BUILDINGS.

OUR APPEARANCE BEFORE YOU TODAY MARKS THE FOURTH TIME IN THE PAST TWO YEARS THAT THE STATES, THROUGH THE CONFERENCE, HAVE PROVIDED WRITTEN AND ORAL TESTIMONY BEFORE A CONGRESSIONAL COMMITTEE IN OPPOSITION TO PROPOSED ZERO BUDGETING FOR THE NATIONAL BUREAU OF STANDARDS' CENTERS FOR BUILDING TECHNOLOGY AND FIRE RESEARCH.

IN WRITTEN TESTIMONY TO THIS SUBCOMMITTEE LAST YEAR, OUR EXECUTIVE DIRECTOR DESCRIBED, IN DETAIL, SOME OF THE IRREPLACEABLE BUILDING TECHNOLOGY AND FIRE SAFETY RESEARCH WHICH THESE TWO CENTERS PROVIDE TO OUR STATES. IN THAT TESTIMONY, WE NOTED THAT "THE CENTRALIZATION OF SUCH RESEARCH AT THE FEDERAL LEVEL IS CLEARLY IN THE NATIONAL INTEREST AND WELL WITHIN THE SCOPE OF PRESIDENT REAGAN'S NEW FEDERALISM .... WERE IT OTHERWISE, WE WOULD HAVE A CHAOTIC AND UNPRODUCTIVE RESEARCH SYSTEM IN WHICH EACH STATE THAT COULD FIND RESOURCES FOR TESTING AND RESEARCH, QUITE PROBABLY, WOULD DUPLICATE RESEARCH BEING DONE IN ANOTHER STATE OR STATES. THIS WOULD CLEARLY BE A WASTE OF TAXPAYERS' DOLLARS."

THIS POSITION WAS LATER SUBSTANTIATED BY THE CONFERENCE IN THE RESULTS OF A DETAILED SURVEY OF EACH STATES' PAST, PRESENT, AND FUTURE BUILDING TECHNOLOGY AND FIRE SAFETY RESEARCH NEEDS. THAT SURVEY (A SUMMARY IS ATTACHED) CLEARLY SHOWED THAT OF THE THIRTY STATES RESPONDING, ONLY TWO STATES FUNDED ANY KIND OF BUILDING OR FIRE SAFETY RESEARCH. WHEN ASKED WHICH AREAS WOULD THEY CONDUCT STUDIES IN IF THEY HAD STATE FUNDS AVAILABLE TO DO SUCH RESEARCH, NEARLY EVERY STATE PUT FORWARD AN ALMOST IDENTICAL LIST OF BUILDING AND FIRE SAFETY RESEARCH ITEMS. THEY INCLUDED: FIRE TOXICITY, INDOOR AIR-QUALITY, AND STRUCTURAL FAILURES. THE RESULTS OF THAT SPRING 1984 STATE SURVEY WERE SHARED WITH THE MEMBERS OF THE SENATE SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE IN OUR SUBSEQUENT TESTIMONY ON THE 1985 FISCAL YEAR FUNDING FOR THE NATIONAL BUREAU OF STANDARDS BY OUR THEN PRESIDENT RICHARD WOLFE OF ARIZONA. FOR THE RECORD, WE HAVE INCLUDED A COPY OF THAT 1984 SURVEY AND MR. WOLFE'S PRESENTATION TO SENATOR GORTON'S SUBCOMMITTEE WITH THIS TESTIMONY.

WHILE THE GOVERNORS OF MANY OF OUR STATES HAVE BEEN VOCAL IN THEIR SUPPORT FOR CONGRESS' EFFORTS TO FIND WAYS OF REDUCING THE FEDERAL DEFICIT, THE CONFERENCE ADAMANTLY MAINTAINS, AS IT HAS FOR THE PAST THREE YEARS, THAT THE ELIMINATION OF APPROXIMATELY NINE (9) MILLION DOLLARS OF COMBINED FEDERAL FUNDING FOR THE NATIONAL BUREAU OF STANDARDS CENTERS FOR BUILDING TECHNOLOGY AND FIRE RESEARCH, IS NEITHER A PRUDENT NOR A PRACTICAL PLACE TO BEGIN TO ACHIEVE A PORTION OF THE FEDERAL BUDGETARY SAVINGS WE ALL DESIRE.

Between 1984 and the present, nothing has changed to diminish the urgent need for continued funding for these two vital federal public safety research programs. No state or group of states and local governments have obtained substantial funding to develop comparable technical research facilities or staff, nor provided the coordination of state building and fire safety research efforts which would warrant the zero funding of either the Center for Building Technology or the Center for Fire Research in fiscal year 1986.

Indeed, events of this past year have only further clarified the continued need for the work of the Bureau's two centers. Three such events highlight that point:

Last April, the Conference testified before the House Subcommittee on Investigations and Oversight on the importance for state and local governments to have access to the expertise of the National Bureau of Standards in investigating significant structural failures of public buildings. In that testimony, we described an effort that was being initiated among NCSBCS, the National Bureau of Standards, the Association of Major City Building Officials, and the American Society of Civil Engineers to draft "model agreements" between NBS and state or local jurisdictions which could be immediately enacted should a building failure occur. Under such agreements, the Bureau would then be invited into the disaster site with the full legal authority of the city or state behind it, to study and report on the probable cause of such a building failure.

That task force, funded jointly by the Bureau and by its three other member organizations, has prepared a preliminary draft model agreement (a copy of which, along with articles on the project, have been included with this testimony for your information). On March 20th this task force will meet here in Washington, D. C. to prepare a revised draft which will subsequently be made available to state and local jurisdictions across the country to adopt and have in place should a significant building failure occur.

As we noted before Congressman Gore's Subcommittee last spring, the structural failure expertise of the Center for Building Technology has proven to be an effective force in helping to prevent future structural failures by providing life saving information concerning the technical causes of such collapses.

A second area of vital importance to the states has been the Bureau's continued dissemination to state building and fire officials and the building codes and standards community of the results of the Bureau's research into fire toxicity, smoke control, indoor air-quality, energy conservation, and structural integrity of building materials. This past September, in Denver, Colorado, NCSBCS and the National Bureau of Standards cosponsored the sixth Joint Technical Conference on Research and Innovation in the Building Regualtory Process (see the enclosed article from the NCSBCS September/October 1984 Newsletter). As a follow-up to the Denver meeting, this month the Conference

SENT OUT ITS BIANNUAL SURVEY OF THE STATES' BUILDING CODE DEPARTMENTS TO ASCERTAIN THEIR FUTURE BUILDING TECHNOLOGY AND FIRE SAFETY RESEARCH NEEDS. AS WE HAVE PREVIOUSLY TESTIFIED TO THIS COMMITTEE, THE RESULTS OF THESE STATE RESEARCH SURVEYS ARE SHARED WITH THE BUREAU UNDER OUR AGREEMENT OF COOPERATION (COPY OF THAT AGREEMENT IS CONTAINED IN RICHARD WOLFE'S MARCH 7, 1984 SENATE TESTIMONY), AND ARE USED TO HELP THE BUREAU PREPARE ITS ANNUAL RESEARCH AGENDA. IN TURN, THE BUREAU REPORTS PERIODICALLY TO OUR STATES ON THE RESULTS OF THEIR RESEARCH PROJECTS.

THIRDLY, JULY 23-25 OF THIS YEAR, THE NATIONAL BUREAU OF STANDARDS AND THE NATIONAL FIRE PROTECTION ASSOCIATION WILL HOLD A NATIONAL FIRE RESEARCH STRATEGY CONFERENCE WHICH WILL PROVIDE NATIONAL DIRECTION AND COORDINATE FUTURE PUBLIC AND PRIVATE RESEARCH INTO FIRE SAFETY. WE ARE ACTIVELY ENCOURAGING THE STATES TO PARTICIPATE IN THAT CONFERENCE (COPY OF NATIONAL FIRE RESEARCH STRATEGY CONFERENCE LETTER HAS BEEN INCLUDED WITH THIS TESTIMONY).

THESE EFFORTS IN MODEL INVESTIGATION AGREEMENTS, DISSEMINATION OF SAFETY INFORMATION, AND THE NATIONAL COORDINATION OF RESEARCH IN BUILDING TECHNOLOGY AND FIRE SAFETY, ARE CLEAR EXAMPLES OF THE VITAL WORK WHICH ONLY THE NATIONAL BUREAU OF STANDARDS CAN PROVIDE ON BEHALF OF THE AMERICAN PUBLIC.

ON BEHALF OF NCSBCS, ITS MEMBERS AND STATES, THE CONFERENCE RESPECTFULLY REQUESTS THAT YOUR SUBCOMMITTEE TAKE THE NECESSARY STEPS TO CONTINUE TO ADEQUATELY FUND BOTH THE CENTER FOR BUILDING TECHNOLOGY AND THE CENTER FOR FIRE RESEARCH. THESE CENTERS MUST BE ALLOWED TO CONTINUE THEIR VALUABLE RESEARCH AND INFORMATION DISSEMANIATION WHICH ENHANCE THE HEALTH AND LIFE SAFETY OF THE CITIZENS OF ALL OF OUR STATES AND TERRITORIES.

THANK YOU FOR PROVIDING THE STATES THIS OPPORTUNITY TO EXPRESS THEIR VIEWS ON THIS IMPORTANT PUBLIC SAFETY MATTER.

Before the

U.S. Senate Subcommittee on Science,

Technology and Space

of the

Committee on Commerce, Science and Transportation

In the Matter of:

Fiscal Year 1985 Budget Proposal)
Funding for the National Bureau)
of Standards' Center for)
Building Technology and Center)
for Fire Research)

Written Testimony
of the
NATIONAL CONFERENCE OF STATES ON
BUILDING CODES AND STANDARDS, INC.

By: Richard E. Wolfe, President
National Conference of States on
Buiilding Codes & Standards, Inc.
481 Carlisle Drive
Herndon, Virginia 22070

March 6, 1984

Before the

U.S. Senate Subcommittee on Science,

Technology and Space

of the

Committee on Commerce, Science and Transportation

In the Matter of:

Fiscal Year 1985 Budget Proposal)
Funding for the National Bureau)
of Standards' Center for)
Building Technology and Center)
for Fire Research)

SUMMARY
Written Testimony
of the
NATIONAL CONFERENCE OF STATES ON
BUILDING CODES AND STANDARDS, INC.

Regarding the proposed fiscal year 1985 zero funding for the National Bureau of Standards' Center for Building Technology and Center for Fire Research, the National Conference of States on Building Codes and Standards, Inc. (NCSBCS) has recently concluded an analysis of existing state research needs in building technology and fire safety and finds:

1) The National Bureau of Standards' Center for Building Technology and Center for Fire Research currently provide the nation's states and local governments with invaluable building and technology research, which the state and local governments depend upon to help them adopt and enforce modern building and fire codes which provide for their public's health and life safety in new and existing buildings.

2) That the states individually or working together cannot and will not be able to build, staff and fund or contract for such research should the Centers for Building Technology and Fire Research cease to operate.

3) That even if the states were able to build, staff and fund or contract for such research, each state would probably duplicate the research programs of other states in the area of building and fire safety, resulting in a potentially large waste of taxpayers' funds.

Based upon these findings, NCSBCS concludes:

> That the centralization of research in building technology and fire safety at the Federal level is a proper and fiscally responsible role for the Federal government and as such, the National Bureau of Standards' Center for Building Technology and Center for Fire Research should continue to be funded as they have been in recent years.

Before the
U.S. Senate Subcommittee on Science,
Technology and Space
of the
Committee on Commerce, Science and Transportation

In the Matter of:

Fiscal Year 1985 Budget Proposal)
Funding for the National Bureau)
of Standards' Center for)
Building Technology and Center)
for Fire Research)

Written Testimony
of the
NATIONAL CONFERENCE OF STATES ON BUILDING CODES AND STANDARDS, INC.

On behalf of the Board of Directors and members of the National Conference of States on Building Codes and Standards, Inc. (NCSBCS), I want to thank Senator Gorton and the members of this Subcommittee for extending the Conference an invitation to testify before you today on the issue of future funding for the National Bureau of Standards' Centers for Building Technology and Fire Research.

The National Conference of States on Building Codes and Standards, Inc. is an organization founded in 1967 to nationally coordinate the building code and public safety interests of our nation's fifty states and several territories. The voting membership of the Conference is comprised of one governor-appointed delegate from each of the states and three U.S. territories. These delegates, for the most part, at the statewide level have the broadest responsibilities for health and life safety in new and existing buildings.

In late January, the Conference learned that as in FY 1984, the FY 1985 budget proposal would terminate funding for the Center for Building Technology and Center for Fire Research of the National Bureau of Standards (NBS). As we understand it, the rationale offered is that research performed by these two Centers should be conducted by state and local governments and the private sector. The Conference is gravely concerned over this matter.

We believe that testimony before both houses of Congress during the FY84 hearings clearly showed the invalidity of this position. Nevertheless, once again, we are being asked to provide justification for the funding of these two vital programs. To prepare our testimony before you today, I requested our NCSBCS staff in early February to develop and mail a questionnaire to all of our state delegate members to ascertain past, present and future research projects in the building technology and fire safety areas. As of February 29th, thirty of our fifty states responded to that survey. A sample of the survey questionnaire and a sheet summarizing the states' responses is attached to our written testimony.

At present only one state (New York on toxicity) out of our thirty respondents is conducting any research in the building technology an fire safety areas. The twenty-nine of the thirty states not conducting such research uniformly noted that their state budgets were too small to even begin comtemplating conducting building and fire safety research and indicated that such research clearly belonged at the Federal level.

Over the past five years only one other state responding to our survey (California) in addition to New York, has conducted research in these areas. In both cases (New York and California), these research projects have been undertaken under emergency conditions and were funded directly by the state legislature and not through the states' regular bugetary processes.

When describing their current research needs in the building technology and fire safety areas, thirty responding states repeatedly identified those research areas in which the National Bureau of Standards is currently engaged: structural failures, computerization of codes, indoor air quality, toxicity, flamability of building materials, smoke control and residential sprinklers.

When asked if their states could independently fund such research in the future if there were not a Center for Building Technology or a Center for Fire Research, all thirty states answered no.

Our survey results show that the centralization of such research at the Federal level is clearly in the national interest, and well within the scope of President Reagan's "New Federalism." Were it otherwise, we would have a chaotic and unproductive research system in which each state that could find resources for such testing and research, as their survey responses note,would duplicate research being done in another state or states. This would clearly be a waste of taxpayers' dollars.

As reported in our survey, state and local governments neither have the research facilities nor the funding resources to conduct the building-related research now carried out by these two Centers. NBS has unique facilities and a staff of researchers with worldwide reputations for their expertise. These resources will not, could not, and should not be duplicated by individual states or the private sector.

From the inception of NCSBCS, in 1967, there has been a close working relationship with the National Bureau of Standards. In 1978, a Memorandum of Understanding was signed by NCSBCS and NBS. This Memorandum calls for NBS to provide technical assistance to NCSBCS and to conduct research needed by the states in carrying out building regulatory responsibilities. A copy of this Memorandum is enclosed for your information.

The use of NBS' research results by NCSBCS and the states, furthermore, has contributed effectively to the National Bureau of Standards' goal of transferring research results and up-to-date technology to the states, and ultimately, for the benefit of building owners and users.

Many technical studies and much research have been carried out in the Center for Building Technology and the Center for Fire Research as a direct result of needs stated by NCSBCS. In 1973, NCSBCS requested the Center for Building Technology to prepare criteria for energy conservation in new buildings in 1974, which were then used by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) as the technical basis for preparation of the ASHRAE Standard 90, "Energy Conservation in New Buildings." This Standard is now used as the basis for the regulation of energy use in new buildings for 48 states. We strongly believe that this is an example of Federal, state, and private sector cooperation at its finest. For the good of the nation, we must not eliminate a vital participant in these cooperative efforts.

In a more recent example of this relationship, slightly over a year ago, NCSBCS concluded a survey of its delegates to determine the need for additional research in the areas of structural integrity and fire safety in buildings. The results of this survey identified 17 areas of needed research. A request was forwarded to the Center for Building Technology and the Center for Fire Research to undertake the state-needed research relating to structural integrity and fire safety in new building construction. Research is now underway in the Center for Building Technology and the Center for Fire Research in response to this NCSBCS request.

In closing, I would like to reiterate the point which our states have made in their recent correspondence to us, that there is no organization presently in the states or in the private sector that could fill the vacuum should the Center for Building Technology and the Center for Fire Research of NBS be eliminated. As our delegate from the State of Illinois put it "the need for the type of research that both of these Centers provide should be obvious. Unnecessary loss of life will continue to occur if research is not performed. The duplication of the same research by 50 states would be sinful."

On behalf of NCSBCS, its officers and delegates, I respectfully request that your Subcommittee take the necessary steps to restore the budget for both the Center for Building Technology and the Center for Fire Research so that they may continue their most valued research; research that enhances the health and life safety of the citizens of all of our states and territories.

Thank you.

MEMORANDUM OF UNDERSTANDING

BETWEEN

THE NATIONAL CONFERENCE OF STATES ON BUILDING CODES AND STANDARDS, INC.

AND

THE NATIONAL BUREAU OF STANDARDS

I. Introduction

The National Conference of States on Building Codes and Standards (NCSBCS) was formed in 1967 in response to "the need for intergovernmental reforms in the area of building codes," as recommended by the Advisory Commission on Intergovernmental Relations.

From the inception of NCSBCS to October 1976, Secretariat services were provided NCSBCS by the National Bureau of Standards (NBS). These services included administrative and technical support. The authority to furnish this support is contained in sections 2(d) and 3 of the NBS Organic Act (15 U.S.C. 272(d), 273).

Many technical studies and much research have been carried out in the Center for Building Technology (CBT) of the Institute for Applied Technology (IAT) at NBS, as a direct result of stated needs by NCSBCS. Examples of such programs include the Laboratory Evaluation and Accreditation Program, Coordinated Evaluation System, Uniform Regulation of Manufactured Buildings and Mobile Homes, and Energy Use Criteria for Standards. The use of these programs by NCSBCS has effectively contributed to the NBS goal of transferring research results and up-to-date technology to the States and ultimately the building owner and user.

With recent growth and development, NCSBCS has matured to the stage of becoming an incorporated entity with administrative self-sufficiency and independence. When NCSBCS entered into contractual agreements with other Federal Government agencies, it realized, as did NBS, that administrative and logistical support by NBS should be transferred from NBS to NCSBCS, while technical research support should be enhanced so as to further the goals of both organizations.

II. Purpose

The purposes of this agreement are to: (1) set forth a commitment of continued mutual support between NBS and NCSBCS; (2) establish a procedure for appropriate joint program planning and continued technical cooperation between the two organizations; (3) outline the general conditions under which NBS and NCSBCS cooperative efforts will be formulated and conducted; and, (4) set forth those technical and other services to be provided either organization by the other.

Through this cooperative effort, both organizations can work together toward the common goal of improving the building regulatory system through the application of research and technology. This work will contribute to the public welfare by providing a safer, more healthful built environment at less cost.

III. Statement of Intent

The past relationship between NBS and NCSBCS proved to be beneficial to both organizations in developing and applying building technology to the special problems encountered in building regulation. It is, therefore, agreed by both organizations that close cooperation and contact will be maintained in the future so as to bring the resources of both organizations to bear on national problems related to (1) deficient and needed new standards and codes for building regulations, and (2) inadequate processes for regulating building design and construction.

1. NBS will carry out technical and research activities for NCSBCS in the following areas:

    a. NBS agrees to provide technical advice and consultation to NCSBCS--its Board of Directors, Committees and individual States, when requested, in areas in which NBS possesses scientific and technological expertise, within the limits of funds and manpower available and consistent with existing policy regarding such services. Requests for such services will be made in writing.

    b. NBS agrees to provide NCSBCS with the latest NBS technical reports, publications and other results of current NBS building research related to building regulatory concerns.

    c. NBS agrees to undertake research for NCSBCS on building regulatory concerns of national interest, when appropriate and subject to existing resources and programmatic limitations. Such research will be conducted on a cost reimbursable basis, when appropriate, under authority of section 7 of the NBS Organic Act (15 U.S.C. 275a) and in accordance with NBS Project Acceptance Criteria. Any such cost reimbursable research will be undertaken by NBS upon execution of a written research agreement between the two organizations.

d. NBS agrees to duly consider the regulatory research needs of the States as expressed by NCSBCS in planning the NBS building research program.

e. NBS agrees to furnish technical expertise to the NCSBCS Standing Committees. NBS agrees to furnish an appropriate technical staff person to participate in the activities of each of NCSBCS's four Standing Committees: (1) Education and Qualification, (2) Codes Administration, (3) Reciprocity, and (4) Standards and Evaluation, and others as mutually agreed upon. This technical support will be provided by NBS to NCSBCS at no cost to the latter organization. These staff persons will be Associate Members of the respective committees and will be selected by the Chief of the Office of Building Standards and Codes Services, Center for Building Technology. Committee participation shall be in accordance with Article VIII, Section 1 and Section 2, of the NCSBCS Bylaws dated September 23, 1976.

2. NCSBCS will carry out studies for NBS and implementation activities based upon NBS research results in the following areas:

a. NCSBCS agrees to undertake surveys, data gathering and other studies related to the building regulatory system for NBS, as requested by NBS, when appropriate and subject to existing funds and manpower limitations. Such activities will be conducted on a cost reimbursable basis through an appropriate contract with NBS.

b. NCSBCS agrees to annually prepare and submit to NBS a written list of high priority research needed to address building regulatory and related problems.

c. NCSBCS agrees to share with NBS nonconfidential progress and other programmatic reports relating to building technology, standards and regulations.

d. NCSBCS agrees to implement NBS building research results when and where appropriate and within limits of resources.

IV. Mode of Operation

In order to facilitate the intent of this agreement, the mode of operation will be as follows:

1. NBS and NCSBCS agree that all cooperative activities shall be funneled through a principal point of contact within each organization. These points of contact are to be the Chief of the Office of Building Standards and Codes Services, Center for Building Technology, Institute for Applied Technology, NBS, and the Executive Director of NCSBCS. To facilitate cooperative activities, the Chief of the Office of Building Standards and Codes Services shall also serve as a Technical Advisor to the NCSBCS Board of Directors.

2. Any information resulting from NCSBCS-supported research at NBS of benefit to the general public will be provided to NCSBCS for either release or approval for NBS to release. Any release of such material by NCSBCS will indicate the source of the research and any release approved for issuance by NBS will acknowledge the support

of NCSBCS. NBS will retain the privilege of individual scientists publishing findings resulting from NCSBCS supported research in professional journals and archival literature.

3. Any information resulting from NBS-supported research by NCSBCS of benefit to the general public will be provided to NBS for either release or approval for NCSBCS to release. Any release of such material by NBS will indicate the source of the research and any release approved for issuance by NCSBCS will acknowledge the support of NBS.

V. Termination

NCSBCS and NBS agree that this Memorandum of Understanding may be terminated by either party 60 days after notifying the other party in writing.

Acting Director
National Bureau of Standards

JAN 03 1978

President
National Conference of States on
Building Codes and Standards, Inc.

January 27, 1978

2/29/84

SUMMARY OF RESPONSES TO

NCSBCS MEMBERSHIP SURVEY - SURVEY OF STATE RESOURCES FOR BUILDING TECHNOLOGY AND FIRE SAFETY RESEARCH

Please Complete and Return to NCSBCS by
Thursday, February 23, 1984

1. Does your current state budget provide for research in:

(Please circle one) (If yes, fill-in approximate amount

a) Building Technology - YES NO (30) Budget Amount $________

b) Fire Safety - N.Y.-(1) YES NO (29) Budget Amount $________

2. If no, why does the current budget not provide for research in:

a) Building Technology

State does not have adequate funding to undertake such research - 16
This is not a proper function of state government & it belongs at Federal level in NBS - 14

b) Fire Safety

State does not have adequate funding to undertake such research - 16
This is not a proper function for states and it belongs at Federal level in NBS - 14

3. Have past state budgets provided for research in:

a) Building Technology-(29)NO YES (1)/California (indoor air quality in mobile homes) Budget Amount $________

b) Fire Safety - (29)NO YES (1)/New York - Toxicity Budget Amount $________

4. If no, why did past state budgets not provide for research in:

a) Building Technology

State did not have adequate funds for such research - 21
This function belongs at Federal level - 9

b) Fire Safety

State did not have adequate funds for such research - 21
This function belongs at Federal level - 9

5. What major topics are or have been the subject of present and past research efforts?

a) Building Technology None - 27
Indoor air quality - 1 Energy conservation in buildings - 2

b) Fire Safety - None - 29
Toxicity - 1

6. If your state is currently conducting research in these areas, in what additional areas of building technology and fire safety is more research needed for which you do not have sufficient

funds for your state to undertake?

a) Building Technology

N/A - 29

b) Fire Safety

N/A - 29
Toxicity - 1
Flammability of room contents - 1

7. If your state does not conduct any research in either or both of these areas, what are your major research needs (e.g. toxicity, structural analysis, etc.) in?

Structural testing/investigation of structural failures - 22

a) Building Technology

Computerization of code processes - 6
Accessibility provisions - 5
Seismic Safety - 3
Indoor air quality - 10
Energy Conservation - 3

b) Fire Safety

Toxicity - 27
Residential sprinklers & smoke detectors - 10
Flammability of building contents - 8

8. Attached is a list of some of the more recent research projects conducted by the National Bureau of Standards Center for Building Technology and Center for Fire Research. If either or both of these Centers ceased to operate, which of these research projects would your state independently be able to fund and conduct? (Please list)

None - 30

Fast acting sprinkler head system (maybe) - 1

9. Do you have any comments you wish to share on the prospect of the nonfunding of the Centers for Building Technology or Fire Research?

SEE ATTACHED SHEET FOR COMMENTS FROM STATE OF ILLINOIS, INDIANA, OREGON, IOWA AND RHODE ISLAND.

List of States that responded to NCSBCS Survey as of 2/29/84:

Alabama, Arizona, California, Colorado, Georgia, Idaho, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Minnesota, Missouri, Montana, Nebraska, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, Utah, Vermont, Virginia, Washington, West Virginia, & Wisconsin.

Attachment to NCSBCS Survey of Resources for Building Technology and Fire Safety Research

COMMENTS FROM STATE OF ILLINOIS, INDIANA, OREGON, IOWA AND RHODE ISLAND:

ILLINOIS - "The need for the type of research that both of these centers provide should be obvious. Unnecessary loss of life will continue to occur if research is not performed. The duplication of the same research by 50 states would be sinful."

INDIANA - "A valuable source of independent research would be lost by the code development and enforcement community. Reliance on trade association research will admit an undesirable bias to consensus standards. Some private sector research is valid; but there are unfortunately a number of instances where research is faulty or misleading."

OREGON - "We would encourage the Federal government to continue to fund the Center for Building Technology and Fire Research and move building regulation from an intuitive to a scientific base. Their research findings would then be used by standards and code making organizations as justification for changes to their code."

IOWA - "Of all the monies spent on research in other fields the benefits derived cannot be any greater per dollar spent than in the NBS."

RHODE ISLAND - "A loss of either of these two (2) Centers would leave a vacuum which could not be filled by either the states or private industry. The need for national objective, professional research agency is paramount to the protection of the publics safety. Such a non-profit oriented agency exists in the two (2) agencies in question."

NCS BCS NEWS

Volume VIII
Number 6
November/
December 1984

National Conference of States on Building Codes and Standards, Inc.
481 Carlisle Drive, Herndon, Virginia 22070; (703) 437-0100

NGA Committee Meets in Boston To Study Housing Policy And Economic Development

The Economic Development and Technical Innovation Committee of the National Governors' Association met in Boston November 14, 1984.

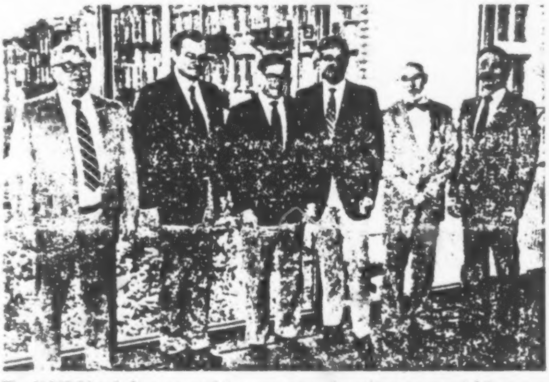
NCSBCS Executive Director Robert Wible attended the meeting as ex officio member of the standing committee.

Massachusetts Governor Michael Dukakis was appointed Chairman of the Economic Development and Technical Innovation Committee for 1984-85. The committee met in Boston to develop policy on financial institutions and housing and look at industrial development bond policy.

The committee plans to study regional development and the impact on federal budgets on economic development in a February meeting.

NCSBCS is actively involved with three other NGA standing committees. These committees and their chairmen are as follows: Human Resources, New Jersey Governor Thomas Kean; Criminal Justice and Public Protection, South Carolina Governor Richard Riley; and Energy and the Environment, Wisconsin Governor Anthony Earl.

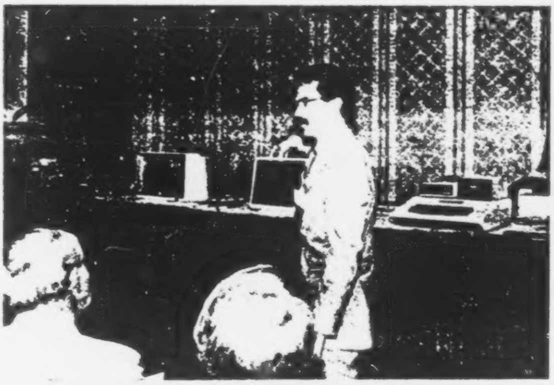
At its Boston meeting, the National Governors' Association Economic Development and Technical Innovation Committee reviewed NGA's housing policy and how federal tax regulations affect economic development. Shown (center) is the committee Chairman, Massachusetts Governor Michael Dukakis.



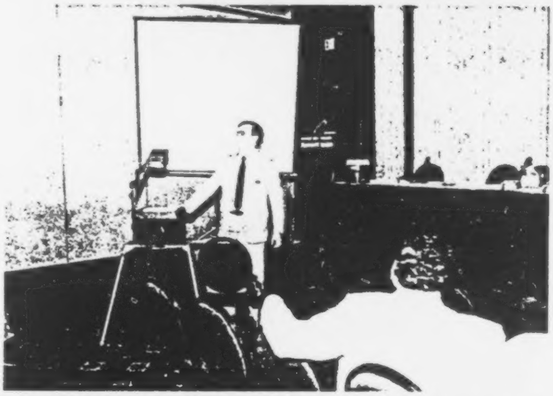
The NCSBCS task force on model agreements to investigate structural failure met prior to the AMCBO Annual Conference in Savannah, Georgia. Members of the task force are: Robert Morris, Jerry Jones, James Gross, John Wenning, James Fincher, and Cornelius Dennis. Not shown are William Crumbaker and Dr. Charles Culver. The model agreements will enable the National Bureau of Standards, at the request of the jurisdiction having authority over the building failure, to investigate any major structural collapse or building failure. (See story "Structural Failure Theme of AMCBO Conference" page 5.)

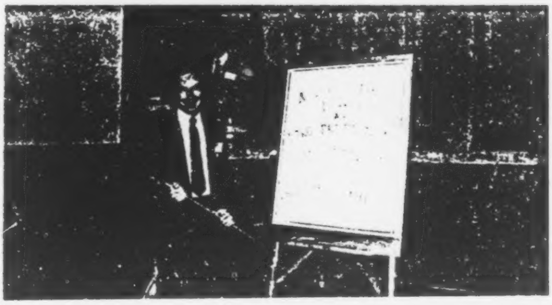
National Building Safety Week
April 14-20, 1985
"Building Safety is NO Accident"

NBS / NCSBCS Joint Technical Session Hears Papers on Computers and Fire Safety



Marriott Hotel





The National Bureau of Standards/ NCSBCS Joint Technical Conference featured presentations on streamlined administration and computer application, and development in fire safety research and technology. The session was held September 11, in conjunction with the NCSBCS 17th Annual Conference in Denver.

Shown clockwise from top left are:

David Collins, AIA, Cincinnati, Ohio, "Codes, Computers, and Rehabilitation";

Harold "Bud" Nelson, NBS, "Emerging Engineering Methods Applied to Regulatory Fire Safety Needs";

James Noland, Boulder, Colorado, "Automated Checking Off Simply Supported Prismatic Reinforced Concrete Beams for Compliance with Code Requirements";

David Hammerman, Maryland, "A Second Look at Fire Protection Code Criteria"; and

Fred Stahl, NBS, "Common Format for the Model Building Codes, An Application of Advanced Techniques for Standards, Analysis, Synthesis, and Expression."

Successful NCSBCS Annual Conference Held in Denver, Colorado

Following the theme, "Building for the Future," the 17th Annual Conference of the National Conference of States on Building Codes and Standards convened September 9 at the Denver Marriott-Hotel City Center in Denver, Colorado. One hundred twenty-six persons attended the Conference which ran through September 13.

During the five-day meeting, NCSBCS members passed resolutions, including a motion calling for accountability in building construction safety; elected new officers; discussed affordable housing, architectural barriers, and laboratory accreditation; and heard technical papers on streamlined administration and computer application of building codes and developments in fire safety research and technology.

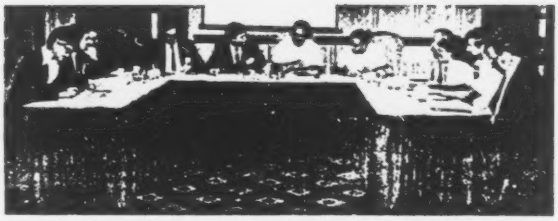
Dynamic Denver Mayor Frederico Peña welcomed the NCSBCS Conference attendees to the city.

Consumer Awareness Project

David Swankin and Rebecca Cohen of the Regulatory Alternatives Development Corporation updated the Board on the NCSBCS Consumer Awareness Project. The project is designed to help citizens understand the building regulatory process and to work more closely with state and local building officials for building safety. A Citizen Action Manual has been distributed to NCSBCS delegates for their comments and approval. The finished Citizen Action Manual will be released in early 1985.

Structural Failure Action Plan

James Gross, Deputy Director of the National Bureau of Standards (NBS) Center for Building Technology and NCSBCS Senior Technical Advisor, spoke before the Board of Directors on the various NBS activities of interest to the Conference. He described the joint NBS/NCSBCS/Association of Major City Building Officials (AMCBO)/American Society of Civil Engineers (ASCE) Task Force to Develop Model Agreements to Investigate Structural Failures (see AMCBO story, page 12). The Board approved an action plan for that project and confirmed the appointment of the nominees to the Task Force.



The NCSBCS Board of Directors approved an impressive agenda of projects for the upcoming year.

Mr. Gross also reported on the November 1983 Conference on Structural Failures held in Santa Barbara, California, and reminded the Board that NBS research facilities are now available for private sector leasing.

Accountability in Building Safety

Two motions from the Codes Compliance and Enforcement Committee were approved by the Board of Directors at their meeting September 13. The Computer Science and Technology Committee was made a task group of the Codes Compliance and Enforcement Committee.

The Board of Directors also moved to appoint a committee to study and recommend a course of action on the following motion from the Codes Compliance and Enforcement Committee to:

1. Establish administrative code provisions which clearly delineate the responsibilities and procedures of the building official, fire official, architect, engineer, contractor, subcontractor, fabricator, etc. The goal of the committee is to define the processes involved prior to permit issuance during construction and the issuance of a certificate of use and occupancy.
2. The committee shall also establish the criterion which requires that an architect or engineer shall be responsible for the design of a project.

Standards and Evaluation

Three motions from the Standards and Evaluation Committee were revised and approved by the Board, including the establishment of the Fire Protection Committee. The NCSBCS staff will hold discussions with the National Fire Protection Association (NFPA) to evaluate the feasibility of splitting the ANSI A225.1-1982 into two standards, one addressing installations and the other addressing parks. The staff will also continue discussions with the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)

VER CITY CENTER
arriott Hotel.

James Gross, National Bureau of Standards, described NCS activities and discussed a structural failure program.

Vol. VIII No. 5 September/October 1984

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David M. Hammerman — First Vice-President
William H. Crumbaker — Second Vice-President
Jack L. Daniel — Secretary/Treasurer
Richard E. Wolfe — Past President

Directors
Mary Beth Bowman — Joseph Cirillo
C. Sutton Mullen — John Wenning

NCSBCS Executive Director,
Robert C. Wible, Publisher
Marla Bethel — Editor

HUD Advisory Council on Manufactured Homes Meets in Washington

A meeting of the Department of Housing and Urban Development (HUD) National Manufactured Home Advisory Council convened October 10 and ran through October 12, 1984 at HUD headquarters in Washington, D.C. The purpose of the meeting was to obtain the views and recommendations of the Council on considered changes in the Manufactured Home Construction and Safety Standards.

NCSBCS members Richard Wolfe (1983-84 President, Arizona), David Preble (Maine), and Mary Beth Bowman (Arkansas), are members of the Advisory Council.

The recommendations of the Council are still under consideration. Updates will be carried in the *Legislative Bulletin*.

NCSBCS delegates Mary Beth Bowman (Arkansas) and David Preble (Maine) were sworn in as members of the HUD National Manufactured Home Advisory Council at a meeting October 10-12 at HUD headquarters.

Structural Failure Theme of AMCBO Conference

"There is a clear need for definition of responsibility in the construction process," said John Hansen, President of Wiss, Jenney, Elftner Associates Inc. at the Sixth Annual Education and Research Conference of the Association of Major City Building Officials (AMCBO) in Savannah, Georgia November 2-3.

Hansen cited five areas that must be considered for safety in structural design: strength, serviceability, stability, fatigue, and durability. As building designs become more complex, Hansen warned conference attendees of the dangers of using computer-aided designs without thinking about proper connections between portions of a building that can be designed by a computer and how it translates into an as-built situation.

The solution to the problem lies with the engineering community, who must pay more attention to its designs, according to Hansen.

Structural Review

Chief building officials of member AMCBO cities described how their city handles structural reviews. A survey of 14 major cities revealed that most of the responding cities conducted structural reviews during the permit process. Two cities had no structural review. The survey further revealed that structural review was conducted primarily on new construction and the majority of the cities experienced a 50% rejection rate.

NBS and NFPA Update

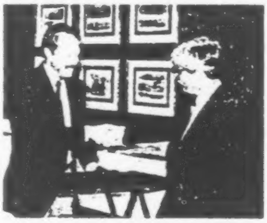
James Gross, Deputy Director of the National Bureau of Standards (NBS) Center for Building Technology, spoke to AMCBO members on NBS' activities and discussed the task force to develop model agreements for structural failures.

Mr. Gross described the new E.6.55 Exterior Building Wall System which sets performance criteria and guidelines for designers, builders, and regulators.

James "Robbie" Robertson, Field Consultant for the National Fire Protection Association (NFPA), described NFPA's work with the model codes.

Officers Elected

Officers for 1984-85 were elected during the two-day meeting. William Justen, P.E., of Seattle was elected Chairman; Paul Imhoff of Pittsburgh is Vice Chairman; and Lee Jensen, AIA, of Milwaukee is Secretary/Treasurer. Outgoing Chairman is Creighton Lederer of Detroit.



William J. Justen, P.E. (left), of Seattle and newly elected Chairman of the Association of Major City Building Officials, presents a gavel plaque to outgoing Chairman Creighton Lederer of Detroit. AMCBO held its Annual Conference November 2-3 in Savannah, Georgia.

AMCBO Education and Research Conference Convenes in Savannah, GA November 2-3

How the nation's major cities handle structural reviews of complex buildings and what can be done to reduce the number of structural failures of buildings is the theme of the Association of Major City Building Officials' (AMCBO) Sixth Annual Education and Research Conference in Savannah, Georgia, November 2-3.

Task Force on Structural Review

National Bureau of Standards (NBS), NCSBCS, AMCBO, and the American Society of Civil Engineers (ASCE) have joined together in a project to develop model agreements between NBS and state or local jurisdictions which would give state and local authorities ready access to the expertise of NBS should a major structural failure occur. The NCSBCS task force will meet Nov. 2 to develop model agreements to investigate structural failures. These model agreements between NBS and state or local jurisdictions would enable NBS, at the request of the jurisdiction having authority over the building failure, to investigate any major structural collapse or building failure. By having the model agreements in place before a disaster, state and local jurisdictions will be able to enact them should a building failure take place.

Jim Gross, Deputy Director of NBS Center for Building Technology, will update AMCBO members on NBS activities and report on AMCBO's joint participation in the task force to develop model agreements for structural failures.

Structural Review Session

Guest speaker at the Friday, November 2 luncheon is noted structural engineer John Hanson, President of Wiss, Jenney, Elftner Associates Inc. in Northbrook, Illinois.

Mr. Hanson's talk will be followed by an afternoon round-table discussion on "Structural Review — How and Who." Each of the chief building officials of the member AMCBO cities will have the opportunity to describe how their city handles structural reviews of building plans.

AMCBO members will also be able to discuss their current building regulatory concerns at a round-table discussion on Saturday, November 3.

The registration fee for the day-and-a-half program is $100 per person. The meeting will be held at the Hyatt Regency Savannah. To register, contact Sandy Townsend at (703) 437-0100. Hotel reservations may be made by calling the Hyatt Regency Savannah at (912) 238-1234.

1985 Meeting Schedule

18th Annual Conference

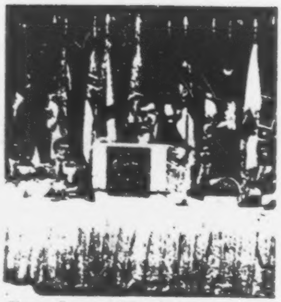
Sept. 8-12, 1985	Portland, ME Sheraton Inn

Board Meetings

Jan. 4-5, 1985	Phoenix, AZ Arizona Biltmore Hotel
April 19-20, 1985	San Francisco, CA Marriott Hotel — Fisherman's Wharf
June 14-15, 1985	Atlantic City, NJ (Hotel not chosen)

Regional Delegate Meetings

March 29-30, 1985	Northeastern / Southern Washington, D.C. (Hotel not chosen)
April 21-22, 1985	Western / Midwestern San Francisco, CA Marriott Hotel — Fisherman's Wharf



Kansas Governor John Carlin (at podium) was elected Chairman of the National Governors' Association (NGA) at its 1984 Annual Meeting in Nashville, Tennessee. NCSBCS 1983-84 President Richard Wolfe and Executive Director Robert Wible attended the meeting, which was held July 29-August 1. NCSBCS is an Executive Branch Organization of NGA and provides direct technical assistance on building codes and standards for four NGA standing committees: Economic Development and Technological Innovation, Energy and the Environment, Human Resources, and Criminal Justice and Public Protection.

Manufactured Housing Production Remains Steady

Manufactured housing production in August 1984 was 29,977 units, down 1% from the all-time high of 30,110 units in August 1983. This slight decline could be attributed to a rise in interest rates. August 1984 production was up about 1% over July 1984 production. Shipments remain approximately 6,000 units over 1983.

David Hammerman (left), Director of Codes Administration for the State of Maryland, and Maryland Governor Harry Hughes display the proclamation from the Governor's office on Building Safety Week, which was held April 8-14, 1984.

11/02/84

DRAFT

MODEL GENERAL AGREEMENT

THIS GENERAL AGREEMENT, is effective as of the _____ day of ____________, 1985 by and between [insert name of jurisdiction] (hereinafter referred to as the "Jurisdiction"), and the National Bureau of Standards (hereinafter referred to as the "Bureau"); an agency of the United States Department of Commerce with offices at Gaithersburg, Maryland;

* * * WITNESSETH * * *

WHEREAS, the Jurisdiction has responsibility for and is charged with the administration, approval and inspections/enforcement of new and existing building construction, renovation and rehabilitation; and

WHEREAS, the Bureau, has developed and maintains a team of licensed, competent, structural engineers and building failure research experts, trained support staff, and appropriate laboratory and research facilities necessary to conduct unbiased, professional research into the technical cause(s) of a building failure or collapse; and

WHEREAS, the Jurisdiction may recently have been or at sometime in the future may be, the site of a major building failure or structural collapse; and

WHEREAS, the Jurisdiction may desire the Bureau to assist the Jurisdiction by making available its expertise to research and determine the technical cause(s) of a building failure or collapse.

NOW, THEREFORE, the Jurisdiction hereby concludes with the Bureau, this Agreement (hereinafter referred to as the "Agreement").

The Jurisdiction, upon request and acceptance by the Bureau, shall receive the benefits of the Bureau's services set forth herein.

Being in receipt of these services the Jurisdiction agrees that it shall assist the Bureau in carrying out its research on behalf of the Jurisdiction by exerting its legal authority for those provisions set forth in this Agreement.

With the assistance of the Bureau, the Jurisdiction shall exercise its authority for providing legal access to the disaster site and debris which have been removed from the site and for accessing technical information and any documents held by the Jurisdiction such as building plans, specifications, test results, etc. from design, construction, and operation of the building or other facility; and

WHEREAS, neither the Jurisdiction nor the Bureau shall have liability for general, special or consequential damages resulting from or claiming to have resulted from the issuance of a final report as to the probable technical cause(s) of a building failure or structural collapse.

THEREFORE, the Jurisdiction agrees that after making a request for the Bureau's assistance and upon receipt of the Bureau's concurrence that it is able to supply such support, the Jurisdiction will then exert all of the legal authority necessary to provide the Bureau's research/investigative team with access to the disaster site and debris which have been removed from the site, and access to all technical information and any documents held by the Jurisdiction such as plans, specifications, test results, etc. from design, construction, and operation of the building or other facility.

The Bureau agrees by its concurrence to the Jurisdictions request that it will begin the investigation within forty-eight (48) hours and will subsequently provide as appropriate:

- technical staff (including non-NBS experts);
- within thirty (30) days the Bureau will provide the Jurisdiction with a statement of scope and timetable for the investigation;
- laboratory facilities and equipment;
- a public technical report, the contents of which the Bureau shall be solely responsible on the technical cause(s) of the failure or collapse, which shall be made available to the profession, the public, and the Architectural Evaluation Performance Information Center; and
- testimony documenting the conduct and findings of the report.

The payment of related costs for conducting each investigation shall be agreed upon by the Bureau and the Jurisdiction at the time that the provisions of this Agreement shall be activated.

Both the Bureau and the Jurisdiction shall establish and maintain a joint communications point to appropriately coordinate public information.

Should either party ever desire to terminate this Agreement, then: within forty-eight (48) hours of receipt of written notice from either the Bureau or the Jurisdiction, this Agreement shall be terminated and all costs incurred in association with that termination shall be agreed upon by both parties.

This Agreement, constitutes the general Agreement between the parties with respect to the subject matter; all prior agreements, representations, statements, negotiations, and undertakings are suspended hereby. No change, alteration, or amendment to this general Agreement shall be effective unless it is in writing and signed by the Jurisdiction and the Bureau.

A failure/disaster specific agreement shall be initiated between the Bureau and the Jurisdiction for each investigation (a sample agreement is attached).

IN WITNESS WHEREOF, the parties hereunder have executed this Agreement as of the day and year first above written.

[name of Jurisdiction]	NATIONAL BUREAU OF STANDARDS
BY:________________________	BY:________________________
________________________	________________________
Title	Title

11/2/84

DRAFT OF SECOND MODEL AGREEMENT - SITE SPECIFIC

MODEL SITE SPECIFIC AGREEMENT

THIS AGREEMENT, is effective as of the ____ day of ______________, 19___ by and between [insert name of jurisdiction] (hereinafter referred to as the "Jurisdiction"), and the National Bureau of Standards (hereinafter referred to as the "Bureau"); an agency of the United States Department of Commerce with offices at Gaithersburg, Maryland;

* * * WITNESSETH * * *

WHEREAS, the Jurisdiction has concluded with the Bureau the attached general agreement on the investigation of structural collapses/failures, and

WHEREAS, a structural failure has occurred within the above-referenced Jurisdiction and that Jurisdiction, with the Bureau's concurrance, desires to enact the terms of the general agreement and to utilize the expertise of the Bureau to investigate a structural collapse/failure described herein.

NOW, THEREFORE, the [insert name of city/county and state] enacts the terms of both this Agreement and the the attached General Agreement with the Bureau to investigate a building structural failure/collapse located at:

[insert address of building:]

WHEREAS, in consideration of such investigative services, the Bureau and the Jurisdiction jointly agree to settle the costs of such work in the following manner:

[insert terms agreed upon]

WHEREAS, should either party ever desire to terminate this Agreement then: within forty-eight (48) hours upon receipt of written notice from either the Bureau or the Jurisdiction, this Agreement shall be terminated and all costs incurred in association with the termination of this site specific agreement shall be agreed upon by both parties.

This Agreement containing three (3) pages, together with the attached general agreement constitutes the total agreement between the parties with respect to the subject matter involved in this specific building structural failure/collapse; all prior agreements, representations, statements, negotiations, and undertakings are suspended hereby. No charge, alteration, or amendment to the disaster specific agreement shall be effective unless it is in writing and signed by the Jurisdiction and the Bureau.

IN WITNESS WHEREOF, the partie hereunder have executed this Agreement as of the day and year first above written.

[name of Jurisdiction]	NATIONAL BUREAU OF STANDARDS
BY:______________________	BY:______________________
______________________ Title	______________________ Title

NATIONAL FIRE RESEARCH STRATEGY CONFERENCE

UNITED STATES DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington, D.C. 20234

NATIONAL FIRE PROTECTION ASSOCIATION
Batterymarch Park, Quincy, MA 02269
NFPA

February 15, 1985

Mr. Robert C. Wible
Executive Director
National Conference of States on
Building Codes and Standards
481 Carlisle Drive
Herndon, VA 22070

Dear Mr. Wible:

On July 23-25, 1985, a meeting will be held at Gaithersburg, Maryland to commence the development of a National Strategy for Fire Research.

We are entering an era in which new technological approaches, that will be applied to the fire problem, offer the promise of significant impacts on losses and costs. Advances in technology, shifts in Federal research policy, and limited resources make it important to examine the direction and strategy for fire research, and particularly opportunities for joint or coordinated private and public sector effort. These developments will present exciting challenges and opportunities for all of us.

You are cordially invited to be a part of an important and far-reaching process that we feel will shape the future of fire research in the United States. The team that is being assembled for this undertaking will be drawn from those who are most affected by the results of the research as well as those who engage in the research process. Your participation and contribution will be critical both to you and to the quality and impact of the resulting strategy.

The meeting is being organized jointly by the Center for Fire Research and the National Fire Protection Association with the assistance of a Steering Committee of well known fire research experts. It is a continuation of the process started at an exploratory conference held in August 1984. The report of that conference is enclosed. At the upcoming meeting at Gaithersburg, we hope to move rapidly forward onto the actual strategic plan--and, with wider involvement of those most vitally concerned.

The work of the conference will include prework, workshops and plenery sessions. Prework includes background reading, completion of a return mailing on fire research needs and issues, and an inventory of ongoing fire research and capabilities. (All those who complete these forms will receive a compilation of the responses.)

Workshop participation, July 23 and 24, is open to those who complete the prework. Attendance at the plenary sessions on the mornings of July 23 and 25 and the opening dinner on July 22 is open to all registrants.

Additional mailings will provide prework information, further details, registration forms, hotel information, etc. A modest fee will be charged to cover out-of-pocket expenses.

We hope you will set aside the time needed for this important project. Please let us know as soon as possible if you will be available so that we may send you the appropriate information. (Please use the enclosed checklist for your response.)

Jack E. Snell.

Jack E. Snell, Director
Center for Fire Research
National Bureau of Standards

Robert W. Grant

Robert W. Grant
President
National Fire Protection Association

2 Enclosures

Mr. **Walgren**. We appreciate your testimony. Let me turn to Mr. Moses. Welcome to the committee.

STATEMENT OF THOMAS MOSES, CHAIRMAN OF THE BOARD, NATIONAL INSTITUTE OF BUILDING SCIENCES, WASHINGTON, DC

Mr. **Moses**. Thank you, Mr. Chairman and members of the subcommittee. I'm chairman of the Board of Directors of the National Institute of Building Sciences, better known as NIBS, an organization authorized by the Congress in 1974 to advise Government and the private sector as to the proper use of building science and technology. I appear here today to provide you with the building communities' views on activities underway within the Centers for Building Technology and Fire Research, as expressed through the Institute's broadly representative consultative council. Also accompanying me is Gene C. Brewer, President of the Institute.

The institute has appeared before this subcommittee three times in recent years with essentially the same message. The Centers for Building Technology and Fire Research contribute valuable information to both the public and private sectors of society. We believe the work of these two centers to be both germane to our industry and serve the public interest. Much of the work conducted by CBT and CFR cannot be done elsewhere in the United States and, due to the NBS charter, the accomplishments of these centers are available to all audiences.

As we have repeatedly stated, the work of CBT and CFR should be continued and is best supported and fostered by nonproprietary interests. In this way, research results and programmatic accomplishments are available to all on an equal basis. Our belief is that these centers help stimulate new technological developments and speed their use in design and construction practice, as a result of open public disclosure, where new information and ideas may be further advanced by innovative individuals and corporate interests.

Last year we cited the fact that the Bureau and the institute entered into a memorandum of understanding on October 18, 1983. Pursuant to that memorandum, a contract was awarded to the institute to support an analysis of building community interests in programs underway at CBT and CFR. In May 1984, a preliminary list of 16 specific research recommendations were agreed upon by the NIBS Consultative Council and forwarded to NBS for appropriate consideration. On October 19, 1984, the Bureau provided a detailed response which demonstrated not only a cooperative spirit between NBS and NIBS, but a sound technical justification for the work already underway at CBT and CFR. Of the 16 recommendations provided by the institute, 14 were being carried out by way of existing or planned research activity. The two additional programs were to be studied further by the centers for appropriate inclusion in future program planning.

It was gratifying to note that projects considered to be of value to the building community were underway at NBS. This was a strong indication that CBT and CFR were on a proper course, responding aggressively to research needs. For the benefit of subcommittee members and staff, we have appended a list of our early recommendations and the Bureau's written response to this statement.

In keeping with our contractual agreement, the institute conducted a second survey of the building community in December 1984, and January 1985, seeking new priority suggestions for needed research activity in building technology. Survey responses have been quite revealing and we will shortly be making our survey results available to NBS. Based upon the surveys received, a strong demand exists for NBS activity in areas relating to: (1) Durability of materials; (2) dynamic loading of structural materials; (3) moisture degradation in warm and humid climates; (4) racking strength for panelized construction elements; (5) coatings for fire resistance and flame spread; and (6) toxicity testing and data for fire and smoke hazard assessment models.

Far more detail is available from institute staff, but early results show a definite industry concern for material performance and life safety.

The institute contends that when Congress established the National Bureau of Standards, it did not so in recognition of the need for Government leadership in fostering scientific advancement. We believe that the Centers for Building Technology and Fire Research are essential parts of an overall framework to improve the quality of the built environment.

Consistent with NBS authority to cooperate with other Government and private entities, develop methods for testing materials, and advise the public on technical matters, CBT and CFR are fulfilling their mission in a propitious and responsible way. As evidence of the cooperation and constructive discourse now seen at CBT and CFR, are memoranda of understanding in effect between NBS and HUD, DOE, NSF, OSHA, NCSBCS, and NIBS. Such communication and technical exchange as provided for in these memoranda is vital in the interest of joint program planning and avoidance of duplicating program effort. It has been reported that nearly 70 percent of the work undertaken by the centers, is for other agencies of Government.

On the horizon, we see many new areas in which CBT and CFR can provide valuable assistance to the building community. In the context of specific recommendations that will shortly be submitted to these centers and this subcommittee, new work in thermal analysis of complete wall and roof assemblies should be pursued. In addition, more emphasis is needed on seismic design and retrofit strategies for older buildings. We have actively worked with NBS in both of these areas and, through the Building Seismic Safety Council, more reliance is being placed on the Bureau for technical support.

Specifically, at CBT, fundamental work should continue in: (1) Structural engineering; (2) material durability and performance; (3) construction safety; (4) thermal analysis of whole systems; (5) mechanical systems and controls; and (6) basic building materials.

And, at CFR, in: (1) Fire risk analysis; (2) fire safety performance; (3) suppression and extinguishment; (4) smoke and toxic gases; and (5) fire-properties of materials.

As a result of our close cooperation and working relationship with CBT and CFR staff, we are becoming increasingly appreciative of their work and we recommend maintenance of program funding in these areas. The loss of this resource would be damaging to the Nation's construction industry that has come to rely upon these centers for thorough and objective data, and for services available nowhere else. We endorse current work within CBT and CFR and we will be certain to provide this subcommittee with continuing reports on our research recommendations which evolve through our survey efforts, and consensus process.

Other efforts underway at the Bureau will have a significant impact on the building industry if they are permitted to be terminated. In particular, CBT provides a focal point for those interested in data and information on international standards. We have long recognized that harmonization of international standards could enhance our ability to export building products. Efforts in this area have yet to be effectively coordinated and we believe that NBS could assist such an activity in a meaningful way. With growing interest within the Department of Commerce on the trade deficit, it would stand to reason to use information available at the Bureau to better understand what changes in policy may be needed.

Let me take a moment to point out that the National Institute of Building Sciences is expanding its research agenda development role to include other agencies of the Federal Government as well as the private sector. This year, in addition to the recommendations being made to NBS are similar suggestions being given to HUD and DOE. The long range objective of our effort, consistent with our authorizing legislation, is to involve all agencies of Government and other sectors of the building community in recognizing priority research needs. The idea here is that through cooperative program planning, overlap, duplication and waste may be avoided in public and private building research efforts.

Mr. Chairman, it is a distinct pleasure to present these views and I hope you will have a question or two for us concerning our statement.

[The prepared statement of Mr. Moses follows:]

A Statement By

Thomas M. Moses, P.E.

on behalf of

The National Institute of Building Sciences

on

The Center for Building Technology and

Center for Fire Research at the

National Bureau of Standards

before

The Subcommittee on Science, Research & Technology
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C.

February 28, 1985

National Institute of
BUILDING SCIENCES

Good afternoon. Mr. Chairman, members of the Subcommittee, my name is Thomas M. Moses, P.E. I am Chairman of the Board of Directors of the National Institute of Building Sciences (NIBS), an organization authorized by the Congress in 1974 to advise government and the private sector as to the proper use of building science and technology. I appear here today to provide you with the building communities' views on activities underway within the Centers for Building Technology and Fire Research, as expressed through the Institute's broadly representative Consultative Council. Also accompanying me is Gene C. Brewer, President of the Institute.

As further background on myself, let me say that I direct and manage Walt Disney World's Reedy Creek Improvement District program in Lake Buena Vista, Florida. The many visitors to Disney World each year can bear witness to our efforts to foster technological advancement in building design and construction.

In addition, I am a past-president of the Southern Building Code Congress International and of the Council of American Building Officials (CABO).

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- durability of materials
- dynamic loading of structural materials
- moisture degradation in warm and humid climates
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- coatings for fire resistance and flame spread
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- smoke & toxic gases
- fire-properties of materials

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Attachments

Appendix A

National Institute of
BUILDING SCIENCES

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April 1984

Research Projects Recommended for the Center for Building Technology

1. Accelerated Testing for Durability of Building Materials
2. Air and Moisture Movements within Insulated Wall Systems
3. Building Equipment and Controls
4. Energy Cost-Benefit Study for Manufactured Homes
5. Heat and Mass Transfer
6. Low-Sloped and Flat Roofing Systems
7. Sound Insulation at Low Frequencies
8. Thermal Analysis

Research Projects Recommended for the Center for Fire Research

9. Development of Integrated Building Fire Risk Prediction Program Model for Code and Regulatory Applications
10. Development of Integrated Building Fire Safety Signaling Systems
11. Evaluating Building Fire Performance of Materials and Assemblies Based on Small Scale Fire Tests and Modeling
12. Housing/Apartment Safety for the Elderly
13. Performance and Hazard Assessment of Solid Fuel Heaters and Their Chimneys
14. Study, Testing and Development of Guide Application Criteria for Smoke Movement, Control and Removal Systems
15. Toxic Hazard Assessment of Building Materials and Furnishings During a Fire

Research Projects Recommended for Both NBS Centers

16. Delivery Systems for Center for Building Technology/Center for Fire Research (CBT/CFR) Research Results

10/19/84

NBS RESPONSE TO NIBS RESEARCH RECOMMENDATIONS

The following describes current Center for Building Technology (CBT) and Center for Fire Research (CFR) efforts in areas recommended by the National Institute of Building Sciences.

1. ACCELERATED TESTING FOR DURABILITY OF BUILDING MATERIALS

CBT has established leadership in accelerated testing of building materials through its development and demonstration of innovative approaches to service life prediction and its strong interactions with the national and international building communities. Two projects are underway:

A. Application of Life-Test Analysis Concepts to Building Materials

Reliable prediction of service life is needed to aid the selection and use of polymeric building materials. But major technical barriers to the development of predictive models arise from the complexity of the degradation processes, particularly the synergistic effects of ultraviolet radiation, temperature, moisture, and other factors. Currently, predictive models and accelerated tests do not account for this interaction. CBT is developing stochastic models incorporating synergistic degradation effects. These models are being validated against laboratory and outdoor test data. Advanced accelerated aging techniques are part of this research effort.

Prior research has led to the development of a stochastic model as a function of two of the above degradation factors (ultraviolet irradiance and temperature) using polymethylmethacrylate (PMMA) as a model material. The model is being extended to include moisture. PMMA specimens are exposed to several relative humidity levels, keeping irradiance and temperatures constant. Degradation is modeled in terms of the chemical and physical changes occurring within the material. The project is aimed at putting durability-related evaluation methodologies on a probabilistic basis by providing an improved service-life predictive model and demonstrating an approach that can be used with a wide range of building materials.

B. Organic Coatings

This research focuses on extending and refining mathematical models and developing improved laboratory test methods to characterize performance properties of coatings. Improved tests are needed to aid development of an ASTM standard for prediction of service life of coatings. The results will be incorporated into standards through interactions with ASTM committees D1 on Paints and Coatings. The findings will also be used in assisting FHWA, military and other government agencies in selecting corrosion protective coatings for steel. Overall, the development and validation of predictive models and the development of improved characterization tools will provide the technical basis for improved selection, use and maintenance of protective coatings.

2. AIR AND MOISTURE MOVEMENTS WITHIN INSULATED WALL SYSTEMS

Several CBT projects are underway which address this recommendation.

A. Calibrated Hot-Box Conduction Transfer Functions

The CBT Calibrated Hot-Box apparatus is being calibrated to determine measurement errors due to heat loss through flanking paths. A series of calibration tests are being performed for steady state and dynamic temperature differences between the indoor and outdoor sides of the wall to determine heat, air, and moisture transmission rates. During FY85, CBT's efforts focus on calibration work and planning a series of experimental test walls that will be designed to investigate parameters such as convection within voids in the wall cavities, thermal mass, and to validate models used to predict performance under a variety of exposure conditions. CBT's participation in a 20-30 laboratory round-robin test program determines the repeatability and uncertainty in the ASTM 976 method of test.

B. Convective Air Movement in Buildings

An NBS computer model has been developed which is capable of simulating the natural convection heat transfer between room surface and adjacent air, natural convective heat transfer between adjacent rooms, and the forced convection between the building and its external environment. The adequacy of this model will be assessed for developing predictive capabilities in areas such as convective heat transfer in insulation systems, the dispersion of contaminants in rooms (ventilation efficiency), and the interzone movement of air.

C. Field Wall-Component Tester

This project is to develop a field method for measuring the thermal conductance of wall components under transient conditions. Presently it is difficult to measure the thermal response of wall components under typical field conditions caused by diurnal climate changes. Existing field methods require large temperature differences and no reversal of heat flux which restricts their use to cold winter months and to surfaces without solar loading. CBT designed a portable calorimeter box to permit measurement of the thermal conductance of wall components under typical transient conditions.

3. BUILDING EQUIPMENT AND CONTROLS

CBT work in this area includes.

A. Systems and Controls Laboratory

This research is developing mathematical models and measurement techniques for evaluating the performance of building systems and controls, encouraging energy conservation in buildings through dissemination of improved control strategies and software, and developing guidelines for automated building management systems. This effort complements CBT's DoE-sponsored research aimed at documenting the energy savings potential of the most commonly employed HVAC control strategies, developing algorithms for building control systems, evaluating the reliability of automated building management systems, and studying the application of sensors in energy monitoring and control systems.

CBT is installing a complete Energy Management and Controls System (EMCS) in the NBS Administration Building and carrying out research with the system to verify and refine the building/HVAC/control system simulation model and the EMCS application algorithms developed in FY 83 and FY 84. In addition, the integration of building services through the use of simultaneous voice and digital communication systems will be explored.

B. Test Methods and Evaluation Procedures for Solar Controllers

The field performance of many active solar systems has been poor. Data from instrumented sites indicate that approximately 40% of the monitored systems performed at one-half or less of design expectations. System controllers and their associated sensors were identified as the least reliable solar components in various studies of field problems.

In FY 84, CBT initiated the development of a research plan for developing test methods and evaluation procedures for controllers. This plan outlines the types of controllers to be studied, and various tests (functional, environmental, electrical, sensor interface, etc.) to be performed. Existing test methods are under review. The plan is based on the results of studies conducted at NBS and SERI and includes recommendations from industry and other organizations. A preliminary draft plan as been circulated for review and comments. When completed, the plan will provide the basis for CBT's laboratory research program. The plan also identifies industry and standards-writing organizations that should be involved to process the recommended test methods and evaluation procedures into national consensus standards.

C. Controls Dynamic Modeling

None of the current building simulation programs (e.g., BLAST 2, DoE 2) accounts for HVAC control dynamics. As a result, there exist few reliable evaluations of the amount of energy waste in buildings due to control dynamics and little information on how to design and operate building control systems to optimize dynamic performance. This research concentrates on developing simulation models to predict the dynamic, "minute-by-minute" performance of control systems for building air handlers and heating/cooling plants. The building HVAC/control system simulation program includes models for building equipment, HVAC components, controls, zones, and the building envelope. Current work concentrates on verifying and refining models of the various components found in building air handlers, and developing a simple building shell model and an interactive user interface for the building/HVAC/control system simulation program.

D. Energy Monitoring and Control System Algorithms

At present, there are no standard, nonproprietary EMCS application algorithms available for use by companies entering the building controls field. Many EMC systems often do not work or only partially work.

CBT is developing public-domain algorithms for HVAC/building applications. Past work concentrated on the completion of algorithms for the control of building air handlers, including optimal start/stop, scheduled time of day stop/start, duty cycling, demand limiting temperature reset, and economizer cycle. CBT is validating and refining air handling algorithms and expanding this effort to include the development of algorithms for the control of centrifugal chillers.

The development and dissemination of validated public domain algorithms for EMC systems should lead to greatly improved EMCS performance, especially for systems made by small manufacturers, resulting in increased energy conservation in commercial buildings.

E. Heat Pump and Air-Conditioner Test Procedures

The Energy Policy and Conservation Act (PL 94-163) and the National Energy Conservation Policy Act (PL 95-619) require the Department of Energy to prescribe test and rating procedures and minimum performance standards for various residential appliances, including central heat pumps and air conditioners. DoE has, since 1975, relied on CBT to assist in the development of the test procedures. Also, DoE has supported the verification of these test procedures and the extension of their scope to include new designs coming onto the market. Also, since the current procedures have not addressed the case where the components of a given system may be manufactured by different companies and assembled in the field (e.g., replacement air conditioner), DoE has directed CBT to develop a procedure by which these units may be rated. This work encourages energy conservation affecting virtually all new-production residential heat pumps and air conditioners in the United States.

4. ENERGY COST-BENEFIT STUDY FOR MANUFACTURED HOMES

No CBT related work underway. DoE has funded Steven Winter Associates, New York, for related work.

5. HEAT AND MASS TRANSFER

Several CBT projects focus on this topic.

A. Convection Within Low-Density Insulation

The one-meter Line-Source Guarded Hot Plate apparatus recently developed at CBT is used in this research because different directions of heat flow (up, down and horizontal) can be applied to insulation materials as thick as 15 in. Here, specimens of different thickness are used with differential temperatures controlled up to 104°F to determine differences in measured thermal transmittance (resistance) when the plates are rotated to give different directions of heat flow. The differences of thermal resistance between heat flow down and heat flow up determine the convection effect for each test. Quantitative measurements are provided to determine convective effects and this information is delivered to practitioners, industry, and organizations such as ASTM and ASHRAE.

B. Heat-Flux Meter Characteristics

Heat flow transducers are comparative measuring devices which must be calibrated or referenced back to an absolute measurement. Large errors in calibrations due to the way the transducers are used are prevalent. These transducers are used extensively in research, measurement, and production work. Precision and accuracy in this type of measurement need improvement so that resulting test method specifications are similarly dependable.

In this project, a method or methods for calibration of heat flow transducers are devised and validated using the NBS guarded hot-plate apparatus as the source for absolute quantitative data. Comparisons are being made with data obtained from other methods or devices such as the CBT calibrated hot box or techniques used by other laboratories. A study of errors for both laboratory and field applications are being made with a view to developing remedial procedures to minimize errors.

C. Thermal Resistance Calibration Standard

This project explores the feasibility of developing a new calibration standard for thermal resistance measurement equipment such as guarded hot plates (ASTM C-177) and heat flow meters (ASTM C-518). At present two materials are available from CBT for calibrating guarded hot plates and heat flow meters. One is a dense fiberglass board and the second is a low-density fiberglass blanket. A need exists to supply the measurement community with calibration samples whose apparent thermal conductivity and thermal resistance are both higher and lower than those now available, using materials that more nearly resemble those that will be measured in current production or using an entirely new calibration material approach; for example, plastics, insulating concretes, loose fill materials, or something like a honeycomb type of material, whose thermal conductivity could be changed at will. Given success in this venture, a measurements laboratory desiring calibration would have the flexibility for calibrating their devices at or near the several ranges of thermal conductivity and temperature values expected to be measured, thus improving the precision and bias of their standard test methods. Much money will be saved by the manufacturing industry if production machines can be set more precisely to produce the R-values required. This, in turn, will lower prices to the consumer.

D. Envelope Thermal Testing Unit

This project, is to determine the usefulness and accuracy of the envelope thermal testing unit (ETTU) developed by the Lawrence Berkeley Laboratory for the Department of Energy. The device is being used on CBT field projects to determine the practical problems and field sources of errors resulting in its use. Guidelines were developed for the use of ETTU. Measurements from the six thermal mass buildings were compared with the known thermal resistance of these walls. A series of test walls of typical construction were built and installed in a small test cell in the NBS environmental chamber. Measurements were made on these walls under various simulated thermal conditions. From these tests the accuracy of ETTU was determined under various environmental conditions. The source of error was determined and the results compared with those of other test methods.

E. Field Measurements of Wall Thermal Mass

Six 20-foot wide and 20-foot long, one-room test buildings (modules) were constructed and their seasonal heating and cooling performance was studied at the NBS Site. All six test modules have the same floor plan, orientation and other common features. The wall constructions are:

1. Insulated light-weight wood frame
2. Uninsulated light-weight wood frame
3. Insulated masonry (mass exterior to wall insulation)
4. Uninsulated masonry
4. Log
5. Insulated masonry (mass interior to wall insulation)

These six test buildings were extensively instrumented for measuring the wall heat transmission, heating and cooling energy consumption, and the indoor comfort condition. A comprehensive series of field measurements have been carried out to date including:

- 14-week winter measurements with the thermostat set for space heating at 68°F
- 3-week spring measurements with the thermostat set for space heating at 68°F
- 3-week summer measurements with the thermostat set for space cooling at 76°F
- 14-week winter and spring night temperature setback measurements
- 3-week summer measurements with the thermostat set for space cooling at 65°F
- 3-week summer measurements with night ventilation used during cool night periods
- Special purpose winter, spring, and summer partition wall tests.

The data obtained during this series of tests demonstrated the effectiveness of thermal mass on heating equipment only under mild climatic conditions and cooling requirements for all the climatic conditions. CBT provided representative data files of measurements of the six thermal mass test buildings covering all of the periods of measurement. The data file is being used by LBL to validate BLAST.

6. LOW-SLOPED AND FLAT ROOFING SYSTEMS

CBT's research is described under the following projects:

A. Thermal Performance of Low-Sloped Roofs

In this research a method to quantitatively determine the thermal performance of low-sloped roofs is being developed. Parameters required to characterize roofing thermal performance are being identified. Some of the factors which may affect the total thermal performance of the roof include: the composition (components) of the roof, type of insulation, joints between insulation boards, the amount of moisture in the roof, the number of penetrations in the roof, and the environment to which the roof is exposed. The method includes mathematical models for assessing thermal performance and in-situ thermal measurements of roofing systems. Recommendations concerning an on-the-roof test method are being performed, and research needs for implementation of the methodology are being identified. Recommendations also are being made as to ways to shorten the time required to measure in-place thermal performance. Recommendations on how to estimate the thermal performance of the Nation's inventory of low-sloped roofs from data for a relatively small number of roofs are being made.

B. Bonded Seams in Single-Ply Membranes

This research provides the technical basis needed to develop or select a test method which reliably predicts the field performance of seams in single-ply membranes. CBT is assessing the adequacy of existing requirements given in standards and specifications for single-ply sheet roofing materials. The assessment will provide a technical basis for preliminary criteria and guide specifications for single-ply membranes.

C. Probabilistic Study of Single-Ply Membranes

In developing and demonstrating a probabilistic method for predicting service life of single-ply roofing membranes, membranes will be subjected over time to both mechanical and thermal stresses. Time-to-failure distributions will be obtained for each experimental condition (minimum of three temperature levels and three mechanical stress levels). The degree of functional dependence of the time-to-failure distribution parameters on temperature and mechanical stresses will be determined through time-temperature superposition and time-mechanical stress equations. Other experimental variables which are being used include membrane characteristics (seam, no seam), and characteristics of the thermal insulation (gap and no gap between insulation boards, insulation and no insulation). Both creep and stress relaxation experiments will be performed. EPDM (ethylene propylene diene monomer) is being used as the first test membrane material, representing the rubber-like, single-ply membrane family. Other membrane materials which may be used in future studies are modified bitumens, thermoplastics, and other rubber-like materials.

7. SOUND INSULATION AT LOW FREQUENCIES

CBT's research includes:

A. "Evaluating Sound Insulation Properties

The need for the development of test methods for low frequency sounds was identified by CBT in the report, Noise Criteria for Buildings: A Critical Review, NBS Special Publication 499 (p. 32 and pp. 37-39). Following this publication, a psychoacoustic research program designed to assess from a human response viewpoint the sound insulation of simulated party walls was developed and partially implemented in a joint Centre Scientifique et Technique du Batiment and CBT (CSTB/CBT) program. The work culminated in the publication of a joint CSTB/CBT report.

B. Measuring Acoustical Quantities in Buildings

CBT's acoustical research places emphasis on the development of accurate, reliable, and unambiguous methods for measuring acoustical quantities in buildings. CBT took advantage of advances in digital signal processing techniques, and of the known relationship between acoustic intensity and the imaginary part of the cross-spectral density between the output of two closely spaced microphones, to develop a capability for measuring acoustic intensity directly rather than inferring it from measurement of sound pressure using diffuse sound field theory. The sound insulation of a partition in a specified frequency band is by definition the ratio, expressed in decibels, of the airborne sound power incident on the partition to the sound power transmitted by the partition and radiated on the other side. Since the acoustic intensity is the acoustic power flowing per unit area, it follows that the acoustic intensity method can be used to develop a test for determining the acoustical insulation of walls based upon measurement of the incident and transmitted sound intensities. This is an important development because the current ASTM and ISO standards require that the sound insulation of a partition separating two rooms be determined by first measuring the difference in the space-time average sound pressure levels when a sound source is introduced in one of the rooms (the receiving room), and then "correcting" this level difference for the acoustical properties of the receiving room. To obtain the "correction term" the decay of the sound field in the receiving room must be determined. However, this measurement, as typically performed, yields ambiguous results. Another major problem with the current practice is that the level difference requires adequate spatial sampling of the mean-square sound pressure in each room. At low frequencies the spatial variance of the mean-square pressure is large because of the low modal overlap that results from low modal density. Moreover, to obtain independent sampling of the sound field, microphones must be located at least half a wavelength apart at each frequency of interest. Since the wavelength is inversely proportional to frequency, the wavelength of sound at frequencies below 125 Hz approaches the dimensions of typical rooms. Accordingly, one cannot find a sufficient number of microphone locations to ensure independent sampling of the sound field. These are major reasons why the sound insulation characteristics of partitions at low frequencies are not measured. The acoustic intensity technique may allow us to circumvent this problem if we are able to devise an accurate procedure for accounting for the phase mismatch between the analog parts of the two-microphone channels as this is a major source of error in acoustic intensity determinations at low frequencies. We are currently working on this problem. CBT's acoustic intensity work is expected to yield a valid measurement method for performing sound insulation measurements not only in the normally accepted frequency range (125 - 4000 Hz) but also at lower frequencies.

8. THERMAL ANALYSIS

CBT's research includes three projects.

A. Multi-Room Thermal Modeling and Large Building Air Movement

This project is developing a comprehensive technique for predicting simultaneous transfer of air, moisture, and heat in and through multi-room buildings. Although numerous building thermal modeling techniques and computer programs exist throughout the United States, none of them can handle the following processes simultaneously: envelope heat transfer, envelope air leakage, envelope solar heat gain, room-to-room heat transfer, room-to-room air and moisture transfer, intra-room air movement, energy consumption by the heating/cooling equipment, indoor comfort, water-vapor condensation, and contaminant migration. Existing models are usually single-room models and dynamic coupling between the heated/nonheated spaces and/or the cooled/noncooled spaces are ignored.

CBT has developed the Thermal Analysis Research Program (TARP) which has been validated by the experimental results of the six test houses at the NBS Site. This program is capable of performing the simultaneous analysis of air and heat transfer in multi-zone structures and the interzone movement of contaminants. Various scaling relationships will be examined to permit small scale models to be used to simulate actual full scale heat and mass transfer. Data from these small scale models are being used to validate the accuracy of TARP to simulate complex heat and mass transfer.

B. Wall Systems Air Leakage Research

A test method is being developed for measuring the efficiency of ventilation in modern commercial buildings. This method determines the minimum amount of air exchange which is effective in removing contaminants from the work space. The method is based on the injection of a tracer gas into various zones of the building initially developed in CBT for application to large buildings for the determination of the buildup and decay of the tracer gas in the work space and in the exhaust air. Tests were made in three different commercial buildings and the results used to determine the effectiveness of the ventilation systems.

Air infiltration and ventilation data are being collected on three additional commercial buildings which have passive solar design features and large atria, in order to increase the data base on large buildings. If possible, fan-pressurization tests and tracer-gas tests will be performed on additional buildings to assess their air leakage characteristics.

C. Evaluation of Thermal Anomalies

This project investigates the adequacy of in-situ methods for quanitifying heat losses due to thermal anomalies. The quantificative use of thermography is being assessed for both the measurement of temperature and heat flux. Laboratory tests are being performed on representative thermographic systems to determine their characteristics for making quantitative measurements. The in-situ use of heat flow meters and calorimeters is being investigated. Guidelines will be established for each of these methods and an assessment of their accuracy will be made.

9. DEVELOPMENT OF INTEGRATED BUILDING FIRE RISK PREDICTION PROGRAM MODEL FOR CODE AND REGULATORY PROGRAMS

A CFR project is underway to further the development of methods for the quantitative measurement of fire risk; i.e., the probability and magnitude of fire caused harm to life, property, or operational capabilities. Probabilistic functions will be integrated into both the key variables of the emerging deterministic models and the choice and weighting of individual simulations executed by those models. The risk measurement form of the models will apply the deterministic models in the stochastic environment of reality to predict the likelihood of selected types of harmful impact (e.g., death, injury, property loss) of a given entity (e.g., building, operation, use) and the change in this likelihood caused by selected mitigation actions. The development of the structure will require attention to each element within the overall model (e.g., ignition, spread, growth, human reaction, tolerances, damageabilities, etc.). The inclusion of stochastic considerations will require the development of a process for assigning values to critical variables according to fire scenario and a process for weighting each scenario. This process may involve Monte Carlo techniques.

10. DEVELOPMENT OF INTEGRATED BUILDING FIRE SAFETY SIGNALING SYSTEMS

No CFR related work underway.

11. EVALUATING BUILDING FIRE PERFORMANCE OF MATERIALS AND ASSEMBLIES BASED ON SMALL SCALE FIRE TESTS AND MODELING

Fire growth and spread and smoke toxicity hazard models are under development that will permit the fire performance evaluation of materials and assemblies for buildings in a rapid and economical manner. Fire property measurement methods are also under development and refinement to provide necessary data inputs to the models.

First models that estimate safe egress time and time to hazard on a single floor are in limited use by fire protection engineers. A new, fundamentally based, fire growth and spread model is under development.

Measurement methods, such as the cone calorimeter which measures rate of heat release using the oxygen consumption method, are in various stages of development.

12. HOUSING/APARTMENT SAFETY FOR THE ELDERLY

A joint project with NRC of Canada on smoke movement and control in elevator shafts will be of particular benefit to the elderly in escaping fires in high rise apartment buildings. Currently, elevators are not used for fire escape.

The objectives of the project are to (1) develop concepts of elevator smoke control systems based on computer analysis using a network airflow analysis model, (2) verify the basic assumptions of network airflow models for elevator smoke control analysis by means of non-fire airflow tests using the Canadian experimental fire tower, and (3) demonstrate the effectiveness of elevator smoke control by means of full scale fire testing.

Further, the work on Fire Safety Evaluation Systems (FSES) for board and care homes will directly impact on that type of housing for the elderly. The FSES will permit the evaluation of the level of fire safety of the housing unit in comparison to an established code such as the Life Safety Code.

13. NBS RESEARCH RELATED TO PERFORMANCE AND HAZARD ASSESSMENT OF SOLID FUEL HEATERS AND THEIR CHIMNEYS

CFR is currently studying hazards related to the installation, operation, and maintenance of solid-fuel burning appliances and their chimneys. Ongoing research in the areas of masonry fireplaces and/or chimney systems, alternate lining systems for masonry chimneys, and coal burning appliances will add information in these areas. Full size appliance and chimney systems, exposed to outside winter conditions and operated over a range of conditions, will provide a base of data for designers and code officials.

Research completed addressed hazards arising from insufficient clearances between appliances or chimneys and surrounding combustibles and from creosoting and chimney fires in factory-built chimney systems.

The results of the research provide data on the intensity and duration of chimney fires and on clearances and methods of protection for combustible surfaces exposed to radiant heating from solid-fuel heating appliances and their chimneys.

14. STUDY, TESTING, AND DEVELOPMENT OF GUIDE APPLICATION CRITERIA FOR SMOKE MOVEMENT, CONTROL, AND REMOVAL SYSTEMS

In FY 84, CFR developed and published (through ASHRAE) an engineering design manual for smoke control systems. Current activities include:

1. The development of a detailed procedure for test and evaluation of the performance of building smoke control systems, suitable for use as an acceptance test for new systems.

2. Theoretical and full-scale experimental program on smoke control for elevators to allow their use for the evacuation of the handicapped during a fire emergency (with National Research Council of Canada).

15. TOXIC HAZARD ASSESSMENT OF BUILDING MATERIALS AND FURNISHINGS DURING A FIRE

The goal of the current toxic hazard assessment program in CFR is to develop a computer model which can quantitatively evaluate the potential hazard to occupants from a fire in large, multi-story buildings. Fire hazards assessed include thermal (both temperature and radiant flux), smoke obscuration, and toxicity. At present, a first-order model which can be used for multi-compartment, single-story structures has been developed. Work to extend this model to multiple stories, add forced convection, and include incapacitation and occupant evacuation is ongoing. Associated projects include the development of test apparatus to obtain the necessary property data and the compilation of existing data for use in these models.

16. DELIVERY SYSTEMS FOR CBT/CFR RESEARCH RESULTS

The Centers' research findings are disseminated broadly to the Nation's building community. Direct interactions are maintained with Federal agencies, designers, developers, builders, manufacturers, professional and technical societies, the research community, building regulators and standards organizations. Technology transfer is accomplished through workshops and conferences, responding to inquiries, producing reports on research, presenting technical programs to industry, serving on over 340 technical voluntary standards generating committees, holding memberships in domestic and international professional societies and chairing committees and subcommittees of professional societies, and providing technical contributions to professional and scientific journals. CBT conducts a monthly workshop on building science and technology to promote communication and coordination in building technology, and CFR conducts a three-day annual fire research conference that reaches over 250 leading researchers and practitioners of the fire community.

CBT and CFR, in turn, learn from the building community about their needs for new research in building science and technology. Building community needs for improved technology are identified for evaluating and preparing technical solutions. Special communication methods are developed to deliver technical information for immediate application by designers, builders, and owners. CBT and CFR publish general purpose reports that summarize their ongoing research, provide listings of publications, descriptions of their unique facilities, and opportunities for guest researchers. These Centers have over 10 Memoranda of Understanding to provide technical support to public and private sector organizations, such as NIBS, NCSBCS, PBS, Air Force and NSF, that lead to improved building practices for more useful and economical buildings.

Mr. WALGREN. Thank you very much for that testimony. I want to say to all three of you that you certainly have provided some direct descriptive support that puts flesh on the structure of an area that is a little hard to understand from the outside and one where there appears to be real value. We want to preserve value where we find it.

I wanted to say in particular along that line that it is good to hear the testimony from the National Institute of Building Sciences. It sounds like you are being able to perform the function that the Congress recognized the potential of in terms of assembling the private sector viewpoints for harnessing and interacting with the Government laboratory resources by both becoming appreciative of value and also being able to guide them in the directions that are the most fruitful for the private sector. That's when Government works best.

We're pleased that your memorandum is bringing about such close contact, and I want to encourage both you and the Bureau in implementing that.

Given the fact that the Bureau's budget maintains the international side of the Institute for Computer Sciences but completely eliminates the domestic side, would you foresee the international side being undercut if the base of activity on the domestic side is wiped out?

Mr. GOSDEN. It's hard to see how one can have a basis for being in the international arena without appropriate national standards and without knowing the background behind them. I think the national base is important for key factors like getting there early and knowing what's going on. Today, the ICST people have about 60 or so committees, gathering intelligence about how to move in the international arena, and which things work either to include or exclude our national position.

Mr. WALGREN. There is a proposal of one of the members of the committee essentially to turn this area over to the private sector and, as I understand it, particularly with respect to the setting of standards. Is that something that would have a positive effect? What would we lose if we did that?

Mr. GOSDEN. In theory it sounds fine. I've looked at the industry, and with the best will in the world, I think it would take several years to make this transition. We can do a great deal of damage in those few years. We would start to lose the resources that we've built up at the Institute. I think that's a very long range, costly solution that would take quite a while to develop and build up. It doesn't exist now, and I don't think it's in the nature of the people in that business environment to be able to do that. They're busy in the national arena where they're essentially competing with each other asking then to turn around and cooperate on the international level, is sort of asking them to play two roles at the same time. I don't think they're able to do this and I don't think they want to do it either. I think they recognize the role the Institute plays in their behalf today as a mediator and spokesman.

Mr. WALGREN. Mr. Connolly, the specter of duplication in all the States of what is able to be done at the national and centralized fire and building research effort seems to be highlighted in the survey that the States conducted. Can you tell us more about the survey just to describe its parameters a little bit more for us?

Mr. CONNOLLY. In essence, what we've done is to identify as many as 40 or 50 potential areas of research inquiry that might be useful in the various building regulatory areas and distributed brief descriptions of what those areas might encompass to each of the 50 States. We asked them to weigh the desirability of research into each of those areas in the results we reported to you.

Mr. WALGREN. It only seems to be logical that there are some things we could do best in one place. If left to the States it's hard to see why it would be any better done there or with out substantial duplication and slippage in terms of time and access to the data developed.

This is the second or third year in a row that both the Building Technology Center and the Fire Research Center have been essentially told that there wasn't much of value there. Have you seen an impact on the morale of the people involved in those programs? What happens when an administration says they don't believe in the future or the value of the work that's going on there?

Mr. MOSES. I think one of the things that becomes obvious, and it's particularly noticeable to those of us on a local level, is that not only does it cause a degradation of morale to some extent and it makes it difficult to secure the kind of competency and expertise that an organization such as the Bureau needs to continue to reach out and bring into its operation. When there is evidence springing from the congressional level or from the administration level that this might not be an ongoing organization, it is somewhat difficult to bring that expertise into the fold. I think if you carefully looked at the activities of the Bureau, you would find that's beginning to have some impact with them—that they really can't bring into the organization the continuing quality of people that we should have there. Obviously it is to our advantage to be able to find a way to put to rest the question whether or not we need this organization and the functions it performs. We feel we need it and if we could put that to rest, the ability of that organization to continue to perform on a high level could be enhanced.

Mr. WALGREN. Would the others like to comment briefly on that?

Mr. CONNOLLY. I would only like to add that I think the continuing work recommendation originates in a fundamental misunderstanding of the kind of research that goes on in these two centers and how it compares to the kind of research that would go on in the private sector or at the State level. Certainly if the work that's being done there could be done in the private sector or could appropriately be done at the State level, we wouldn't be here. We're not generally in favor of increasing the scope and breadth of the Federal Government. It just simply could not if you understand what they do.

Mr. GOSDEN. With respect to your question on morale, I believe that the dramatic budget cuts that have been repeatedly proposed for the Computer Institute during the past four years have had a continuing effect on morale. I believe it must have some effect upon the capacity of the people to get the work done, and it must certainly contribute to the distraction of the top level people in responding to this, and replanning and rebudgeting. I believe it also affects to some extent their ability to work well with industry. Industry likes to feel that somebody will be working there next year and the year after. Without that it would be even harder to set up any transfers or to set up any cooperative arrangements. I would love to recommend that you find some way to get some more stability into this situation.

Mr. WALGREN. Mr. Boehlert.

Mr. BOEHLERT. Mr. Chairman, I hate to play the role of the spoiled sport, but I think I'm destined to do that this afternoon. I can't recall ever sitting through a hearing like this where I've agreed more with the witnesses on both panels than I do today. I want to comfort all of you by saying that I think we're going to accomplish all of the above. Don't be overly concerned.

Mr. Gosden, on page 8 of your testimony, I think the essence of it is right where you say the Institute has been a major catalyst and focus for success in the international standards area and you're so right. I think we're going to be OK in all the areas.

Mr. Connolly, you know and you said it eloquently, and I know as a former county executive, no way in hell is a State government going to pick up the tab for the work that's being done, and local governments certainly don't have the resources.

Mr. Moses, I hope you will provide us with the survey results that you're going to give to NBS. I just want to thank you all for coming here and the reason I think I'm being a spoiled sport is this: I've never been on that side of the table as a witness from the real world, but I know what usually happens. We go back to our offices and say boy that was a tough afternoon and we really grilled those witnesses and we pinned them to the wall and you guys probably go back to the office and say boy did we tell those Congress people; we got them straightened out. Today this is almost like a love-in and I'm very pleased to say that I find myself in agreement with you and I've noticed both sides a lot of nodding throughout this hearing.

Thank you for your very eloquent testimony.

Mr. WALGREN. Thank you very much and on behalf of the committee, we do appreciate the record you've built. I join with Mr. Boehlert in more than hoping that that record will enable us to send the kind of signals that will support these efforts and perhaps solve some of the morale problems that they would otherwise have.

Thank you very much for coming.

[Whereupon, at 4:15 p.m., the subcommittee recessed to reconvene at the call of the Chair.]

1986 NATIONAL BUREAU OF STANDARDS AUTHORIZATION

WEDNESDAY, MARCH 6, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Science, Research and Technology,
Washington, DC.

The subcommittee met, pursuant to call, at 1:35 p.m., in room 2325, Rayburn House Office Building, Hon. Doug Walgren (chairman of the subcommittee) presiding.

Mr. Walgren. Let me call this to order and we'll begin.

Today's hearing is the third on the National Bureau of Standards fiscal year 1986 budget request. In the first two hearings, we heard from Dr. Ambler and his laboratory directors, along with Assistant Secretary Merrifield of OPTI, and the Director of NTIS, Director Caponio. In the second hearing, we heard the views of the business and university community on the NBS budget, concentrating primarily on budget reductions.

Today, for the most part, we want to concentrate on the favored portions of the Bureau's submission—the cold neutron source, ceramics, and robotics—to understand and appreciate why these areas have been identified for increased effort. We also want to hear spokesmen for two programs—steel research and evaluation of engineering data—which the Bureau would like to have increased, but which did not fare as well in other parts of the administration, as the overall budget submissions to various committees of the Congress make out.

Finally, we will learn more about the merits of two programs the administration has marked for extinction—the Center for Fire Research and the Office of Productivity, Technology and Innovation. This testimony will complete our examination of each of the administration's proposed increases and reductions and will serve as the basis for the subcommittee's recommendations to the full committee for fiscal 1986 authorization funding.

I want to ask unanimous consent, which seems relatively easy to do at this point in the record, for two actions as chairman that make sense. One is that the staff, both minority and majority, look through the numbers of submissions that we have received including correspondence concerning OPTI and the National Bureau of Standards, and select appropriate items for inclusion in the record of this hearing. And second, I would also ask unanimous consent for the staff to review last year's record, particularly with respect to those items that have been under attack in this year's budget, for inclusion of portions of last year's testimony as reference material for this year's consideration. We went over much of this ground last year. This administration has a penchant for coming back in the same position a year later as it presented the year before, and I think some of the materials that we, through a lot of effort, gathered in last year's budget review are certainly applicable, and I would like to have the staff look at that record and suggest portions that are directly applicable to the issues that the members would consider this year.

Well, with that, let me call the first panel, Dr. Seitz, Dr. Prindle, Dr. Leonard, and Dr. Berry. I know that other members of this committee, particularly Congressman Lundine and Congressman Ritter are particularly interested in introducing Dr. Prindle and Dr. Leonard respectively, out of their personal relationships with you gentlemen. I know that they would be giving you a special welcome, and will probably be along shortly as their time permits.

But let me say at the outset that written statements will be made part of the record and invite you to summarize or outline or emphasize the points that you feel really deserve to be underscored in whatever way you feel is most appropriate. So let's start then with Dr. Seitz and continue with Dr. Prindle and Dr. Leonard and Dr. Berry, in that order.

Dr. SEITZ. Thank you.

Mr. WALGREN. You'll know how you'll proceed. Dr. Seitz, welcome to the committee.

STATEMENTS OF DR. FREDERICK SEITZ, PROFESSOR EMERITUS, ROCKEFELLER UNIVERSITY, NEW YORK, NY; DR. WILLIAM R. PRINDLE, DIRECTOR OF ADMINISTRATION, R&D DIVISION, CORNING GLASS WORKS, CORNING, NY; DR. JAMES LEONARD, VICE PRESIDENT OF TECHNOLOGY, BETHLEHEM STEEL CORP., HOMER RESEARCH LABORATORY, BETHLEHEM, PA; AND DR. STEVE BERRY, DEPARTMENT OF CHEMISTRY, UNIVERSITY OF CHICAGO, CHICAGO, IL

Dr. SEITZ. Thank you very much, Mr. Chairman. I will follow your instructions and place emphasis on the major aspects of the report issued by the National Research Council concerning large equipment for materials research. In addition, I will focus on aspects which deal with the National Bureau of Standards

About a year ago, the academy was asked by Dr. Keyworth to carry out a study which would propose priorities among the various requests that were being received to fund large equipment for materials research. The Department of Energy was designated to be the agency which would work with the Academy in handling the financial aspects of the study. Moreover, it was agreed at start that we would focus on items which cost at least $5 million and in some cases a great deal more. Dr. Dean E. Eastman, a very brilliant young scientist from the International Business Machines corporation and I served as cochairman. We were joined by a broad committee composed of individuals who are concerned with many aspects of materials research, such as the physics and chemistry, and the applied areas such as ceramics, metallurgy, electrical engineering, and so forth. Moreover, to make the study truly representative of the full range of interests, we selected on the committee not only those who were specifically interested in large-scale equipment but also a number of individuals whose activities centered in the more or less tradition areas of bench research sometimes designated by the term "small science."

It should be emphasized that our committee recognized that both types of activities are highly important. One needs large-scale equipment to do unusual things as the frontier advances but one also needs individuals who work at the more traditional scale. Small-scale research is not only of continuing fundamental importance for initiating developments but also provides the basis for much of the educational work involved in training a new generation of research scientists and engineers. One does suspect, however, that as time goes on, the center of gravity of research will move more and more toward the utilization of large equipment.

Our report focused on two kinds of priorities for large-scale equipment, namely, priorities for completely new facilities which we treated on a generic basis without trying to say where they should be. We did, however, propose something in the nature of a time scale for funding. Alongside this, we also discussed the updating or enhancement of existing equipment in order to expend its range of usefulness. In this connection, it should be recognized that much of our existing equipment is now 20 years or so old and that, as a result, we have fallen behind other technologically advanced countries, in particular, the countries of Western Europe.

The new facilities which are not what concern us specifically here today, relate to a 6 GeV synchrotron radiation facilities that would give us a new dedicated resource for producing high intensity beams of x rays in the range of 10 keV; an advanced steady State neutron facility for experimental research that would replace a reactor built some 25 years age at Oak Ridge National Laboratory; a one to two GeV synchrotron radiation facility that would provide copious quantities of x rays at a somewhat lower range of energy than the 6 GeV machine but which would be very useful for work in the field of chemistry and in applied areas. Finally, we recommended the construction of a high intensity pulsed neutron facility of much higher power than those now available at Argonne National Laboratory and Los Alamos National Laboratory, but proposed that this be put off until sometime in the future after certain modernizations have taken place in existing equipment, particularly the equipment at the two laboratories I have just mentioned.

In order of priority, the following recommendations were made for the provision of new capabilities at existing facilities. First, we recommended the addition of cold neutron channels at the existing nuclear reactors at the National Bureau of Standards and at Brookhaven National Laboratory. Such channels would add enormously to the utility of the two reactors for research purposes. Our committee went out of its way to obtain the best estimates it could for the cost of these enhancements and estimated that such cost would be between $25 and $30 million in each case depending upon the details.

Let me say a few words about cold neutron research. As you know, neutrons are produced in copious numbers in nuclear reactors. Moreover, they are generated with a range of energies. In a properly designed arrangement, it is possible to take some of the neutrons and send them down a channel which has been cooled to very low temperatures. The neutrons which flow down such channels are cooled off in the process and in consequence have a very long wave length associated with them. This makes it possible to use them in a number of novel ways, for example in determining the structure of large molecules such as occur in manmade polymers and biological materials.

We do not currently have adequate access to cold neutrons in the United States at the present time. The leading laboratory in the world is in France and was developed as a result of cooperation between the French, Germans, and English. While American scientists are occasionally given access to that equipment, first priority belongs to the Europeans. Thus, there is a much greater demand in our own country for access than is possible at the present time. The enhancement of facilities at the National Bureau of Standards and at Brookhaven will do much to remedy the situation in the period immediately ahead.

During the course of our study, we had staff members from both the National Bureau of Standards and Brookhaven present their proposed programs and went over them in detail. We concluded that both were excellent in concept and design. I should here emphasize that both of these laboratories are freely open to qualified individuals on a truly national basis so that they can be used by individuals from other national laboratories, universities or industry, as well as by the staffs at the laboratory. In round numbers I think it is safe to say that about two-thirds of the time is utilized by outsiders in both cases. Clearly it would also provide some of the user time to foreign scientists as circumstances and cooperative programs make feasible. In this connection, I should emphasize that the National Bureau of Standards has a very good tradition of cooperation with individuals outside its own walls. Thus, the entire user community feels that the NBS deserves very strong support in its request for the expansion of its reactor facilities.

I will not burden you here with further details of the ways in which cold neutrons can be used. You will find materials of that kind in the report. I might also add that you will find a detailed description of all of the matter which were reviewed by our committee in this report. Perhaps I should mention that the urgent need for this report was indicated by the fact that the committee completed its study in about 6 months as a result of an essentially continuous series of meetings. Moreover, we had cooperation from everyone we asked both at home and abroad during the course of the study.

Mr. **Walgren**. Without objection, we'll ask the staff to look at that at this point in the record and—and reference it appropriately.

[The report follows:]

Major Facilities for Materials Research and Related Disciplines

Major Materials Facilities Committee
Commission on Physical Sciences, Mathematics, and Resources
National Research Council

NATIONAL ACADEMY PRESS
Washington, DC 1984

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

Support for this project was provided by the Department of Energy under Grant No. DE-FG01-84ER45062 and by the National Science Foundation under Grant No. DMR-8408982.

Available from
Major Materials Facilities Committee
Commission on Physical Sciences,
Mathematics, and Resources
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

NATIONAL RESEARCH COUNCIL

2101 CONSTITUTION AVENUE WASHINGTON, D. C. 20418

OFFICE OF THE CHAIRMAN

July 24, 1984

Dr. George J. Keyworth, III
Director
Office of Science and Technology
  Policy
Old Executive Office Building
Washington, D.C. 20500

Dear Jay:

I am pleased to transmit a report on major materials facilities, prepared at your request by a committee of the National Research Council (NRC). As with all reports of the NRC, the report is the responsibility of its committee, but its review has been monitored by the Academies' Report Review Committee.

The report presents priorities both for new facilities and new capabilities at existing facilities with initial cost of at least $5 million. The *new facilities* in order of priority are: a 6 GeV Synchrotron Radiation Facility; an Advanced Steady State Neutron Facility; a 1 to 2 GeV Synchrotron Radiation Facility; and a High Intensity Pulsed Neutron Facility. The *new capabilities at existing facilities* in order of priority are: centers for cold neutron research, incorporating guide halls and instrumentation; insertion devices on existing synchrotron radiation facilities; an experimental hall and instrumentation at the Los Alamos National Laboratory Pulsed Neutron Source; upgrading of the National Magnet Laboratory; and enriched pulsed neutron targets.

The context for these recommended priorities is given in the executive summary, and more fully set out in the three chapters of the report proper. Chapter I titled, *Materials Research: Facilities and Modes*, describes the nature of materials research, by whom it is done, and for what purposes; and the major facilities for synchrotron radiation, neutron scattering, and high magnetic field research, in the United States

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TO SERVE GOVERNMENT AND OTHER ORGANIZATIONS.

and other countries. Chapter II titled, Major Materials Facilities: Science and Technology, outlines the research that has been done with existing facilities and that will be facilitated with the proposed new installations. Chapter III titled, Conclusions and Recommendations, offers a fuller rationale for the priorities, briefly analyzes costs, and surveys facilities considered but not included in the priorities by virtue of the Committee's charter and without necessarily passing any judgment on their relative merit.

As acknowledged in the preface to the Report, setting priorities was a "difficult and painful" task for the Committee. It should be understood that, in accordance with your request, the report did not address the question of balance between support for "small" and "big" science in materials research. The Committee hewed to its charter: to set priorities among major facilities considered important to the nation's research efforts. Therefore, the report should not be read as advocating increased support for major facilities to the detriment of smaller scale science, typically done at universities, governmental laboratories, or regional centers. Indeed, quoting from the preface, "additional panels should be convened to address other aspects of materials research and to review previous recommendations in light of new information."

With those caveats in mind, I believe this report to be a major contribution to guiding the science and technology of the United States. All of us understood that selecting priorities is a difficult task. That it was done, with care and wisdom, is due to the members of the committee, to its staff, and to the Committee's leaders, Frederick Seitz and Dean Eastman.

I commend the report to your attention.

Sincerely,

Frank

Frank Press
President

Attachment

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PREFACE

The President's Office of Science and Technology Policy in November 1983 asked the National Research Council (NRC) to assist in establishing priorities for major facilities for materials research. These facilities, defined as those with initial cost of at least $5 million, include, among others, sources of synchrotron radiation and steady state and pulsed neutrons.

A committee of twenty-two members was formed within the NRC Commission on Physical Sciences, Mathematics, and Resources, representing the diverse disciplines that use facilities for major materials. The Committee's membership was also intended to mirror the differing research styles and the spectrum of organizations where the research is done. Scientific work with materials varies from that principally requiring laboratory-scale instrumentation to that dependent on the availability of major facilities that the Committee was asked to address. It is done by governmental, academic, and industrial scientists and engineers.

The Major Materials Facilities Committee first met late in January 1984 and three times thereafter. Four panels of the Committee were formed: three to consider and make recommendations to the Committee regarding needs for synchrotron radiation, neutron scattering, and other specialized materials research facilities; and a fourth to analyze the budgetary implications of various sets of priorities. During its tenure, the Committee, or one of its panels meeting separately, was informed of or heard detailed presentations on the status and promise of many of the U.S. major materials facilities falling within its charge. Further, the President's Science Advisor, the directors of several national laboratories, and senior research officials of several federal agencies met with the Committee. [A list of presentations to the Committee is in Appendix C.] Finally, the Committee had available to it recently completed and advance drafts of reports relating to its topic, done by the National Research Council, the Department of Energy, and other organizations. In all, this report is the result of more than 6 months of extremely intensive efforts by the Committee, its panels, and its staff.

In addition to the executive summary, the report contains three chapters. Chapter I describes the facilities, research styles, and research performers of materials research in the United States. It also offers a brief summary of the status of U.S. facilities vis-a-vis those of other countries. Chapter II outlines scientific and technological accomplishments using major materials facilities and suggests the likely direction of future research. In short, it presents the scientific and technological rationale for the recommendations in this report. Chapter III expands on the conclusions and recommendations given in the executive summary.

A continuing concern throughout the Committee's deliberations was the possible misinterpretation, even misuse, of its report. As is emphasized several times in the text that follows, the knowledge generated by materials research comes from diverse research styles and performers, each vital to the total effort and each complementary to the other. These varying styles must each be well supported, for the health of the total effort in materials research. To deny funding to smaller scale research to support major facilities is destructive. Therefore, the recommendations in this report should be read and interpreted for what they are: a statement as to priorities solely for major materials facilities. The Committee did not address, and this report does not imply, any judgments on the total spectrum of work embraced by materials research.

By the same token, additional panels should be convened to address other aspects of materials research and to review previous recommendations in light of new information. Such panels, by responding to specific aspects of materials research needs, can contribute to the long-range planning and to the setting of priorities for the materials research field.

The task before the Committee was difficult and painful. Its recommendations, and its omissions, would, if they were adopted, have a major effect on the future direction of materials research in the United States, on the institutions where major facilities are or may be based, and, likely, on the future competitive status of major segments of United States technology. That the Committee fully agreed to the need to recommend priorities testifies to the cosmopolitan views of its members; that reaching agreement on priorities was difficult testifies to their strong beliefs in the value of particular facilities.

The National Research Council is indebted to the members of the Committee for their patience, goodwill, and dedication to an arduous and trying task.

Dean E. Eastman
Frederick Seitz
Co-Chairmen, Major Materials
  Facilities Committee

CONTENTS

PREFACE xi
EXECUTIVE SUMMARY 1
Conclusions and Recommendations 3
Recommended Priorities 3
I. MATERIALS RESEARCH: FACILITIES AND MODES 7
Universities 7
Federal Laboratories 10
Industry 10
Major Materials Facilities 11
II. MAJOR MATERIALS FACILITIES: SCIENCE AND TECHNOLOGY 17
Synchrotron Radiation, Neutron Scattering, and Magnetic Fields 17
Synchrotron Radiation Research: Past and Future 21
Neutron Scattering Research: Past and Future 30
Research with Magnet Facilities: Past and Future 37
Advanced Technology Needs: Applications of New Facilities 40
III. CONCLUSIONS AND RECOMMENDATIONS 43
Recommended Priorities 44
Estimated Costs of the Recommendations 49
Other Specialized Facilities Considered by the Committee 54

APPENDIXES

A. REPRINT: George H. Vineyard and L. M. Falicov, "National Facilities for Research in the Physics of Condensed Matter," Review of Scientific Instruments, Vol. 55, No. 4, 620-630, April 1984 57

B. REFERENCES AND RELATED LITERATURE 69

C. LIST OF PRESENTATIONS MADE TO THE MAJOR MATERIALS FACILITIES COMMITTEE (the complete presentations will appear in a supplement to this report) 73

D. PRESENTATIONS TO PANELS 77

EXECUTIVE SUMMARY

The science of condensed matter, or materials research, deals with the properties of solids and liquids and their interfaces. It is interdisciplinary, involving materials science, major areas of physics and chemistry, and the earth sciences, biology, and medicine. The understanding of the behavior and properties of materials undergirds every major technology; as a consequence, strength in materials research is essential to national capacities in advanced technology and, hence, to economic competitiveness.

Like all sciences, materials research depends on instruments, with these instruments ranging from laboratory size, such as mass spectrometers, to major national facilities, such as sources of synchrotron radiation and neutrons.

This report deals solely with major facilities. That was the Committee's charge. The facilities considered were those that are national in scope, with initial costs on the order of $5-10 million or more, intended primarily for research on materials. However, materials research done on a laboratory scale is equally vital to the future strength of U.S. materials research. Support for laboratory-scale science is complementary to, not competitive with, the support for major facilities recommended in this report.

The relatively high costs of major facilities for materials research dictate that priorities be established; and the Committee in this report recommends priorities for major new facilities and new capabilities at existing facilities, for materials research and related fields. The recommended priorities involve three types of facilities, providing synchrotron radiation, neutrons, and high magnetic fields.

Synchrotron radiation, produced when energetic electrons are deflected by a magnetic field, provides over a broad spectral range the most intense source of photons now available. Such radiation can be intensified further by orders of magnitude by using insertion devices--wigglers and undulators--that put a series of sharp bends in the electron trajectories. Synchrotron-produced photons interact strongly with atomic electrons, thus, offering a means of probing the details of the electronic structure of materials.

In contrast, neutrons, which are produced by nuclear reactions, interact most strongly with atomic nucleii. Neutrons are thus uniquely suited to the study of lattice dynamics and molecular configurations. In addition, since the neutron has a magnetic moment, neutron scattering offers a unique means of probing the magnetic properties of materials. The most effective use cold neutrons, which have very low velocities, requires that they be transported through special tubes, whose walls reflect those neutrons with minimum loss, to large experimental areas called guide halls.

High magnetic fields are essential to the study of a variety of technical and fundamental problems. In particular, high magnetic field facilities are essential to the development of improved superconductors and, in turn, make it possible to construct more efficient superconducting magnets capable of achieving still higher fields.

The Committee applied the following criteria in establishing its priorities:

- o The importance of each facility for frontier research in materials, and consideration of research needs of other fields, including biology, chemistry, atomic and molecular physics, plasma physics, earth science, and medical science.
- o The importance of each facility for applied research in areas of national priority; that is, economic competitiveness and security.
- o The availability of other, less costly alternatives for accomplishing comparable scientific, technological, and educational goals.
- o The contribution of each facility to a long-term national plan for such facilities, including considerations such as capital investment, operations costs, and technical feasibility.

Additional criteria that should be considered in evaluating proposals for new facilities include:

- o Technical and scientific resources at the laboratory or university site, including schools or departments in related areas.
- o Access and ease of use by extramural academic, industrial, or government laboratory investigators.
- o Role of the facility relative to a new or strengthened mission of its home laboratory or university.
- o Potential of each facility for training scientists and engineers.

Further, new facilities to be fully effective must be dedicated, that is, used exclusively for synchrotron radiation or neutron based research. Finally, to serve the entire community optimally, the geographic distribution of facilities should generally be taken into account.

CONCLUSIONS AND RECOMMENDATIONS

The Committee's recommended priorities for major facilities--both new facilities and new capabilities at existing ones--embody two prerequisites:

- That they are accompanied by expanded support of smaller materials research programs, including related instrumentation. Research on this scale continues to provide much of the fundamental new science in the field and to train a large fraction of our scientific and technical manpower.
- That resources must be provided to operate existing user facilities productively. In addition, the approved enhancements of major synchrotron radiation facilities at the Brookhaven National Laboratory, Stanford University, and the University of Wisconsin should be completed expeditiously, since it will require several years to more than a decade before the new facilities recommended in this report can contribute to the research effort of the United States.

RECOMMENDED PRIORITIES

The Committee's recommended priorities for the development and construction of facilities during the next decade include two categories:

- Major new facilities, and
- New capabilities at existing facilities.

These categories complement one another in function, time scale, and required resources. New capabilities at existing facilities are essential for scientific and technological needs in the next decade, while the long lead times needed to construct major new synchrotron radiation and neutron facilities require that we start now with the planning and design of such new facilities. They also require that we begin immediately to implement new capabilities at existing facilities. The Committee concludes that both categories are essential for the effective evolution of science and advanced technology in the United States in the next decade and beyond.

The Committee also recommends the convening of additional panels to address other important aspects of materials research.

Major New Facilities

The Committee's recommendations for the construction of major new facilities are listed below in order of priority.

1. A 6 GeV Synchrotron Radiation Facility. This would be designed to make optimum use of the new scientific and technological opportunities presented by insertion devices. These devices, by providing radiation having orders of magnitude greater brightness than currently available, will make it possible to expand on the seminal research using synchrotron radiation carried out in the past decade. A synchrotron radiation facility with a storage ring energy of about 6 GeV will offer both identifiable and unforseeable new opportunities for research throughout the electromagnetic spectrum. It is optimal for providing radiation from undulators at about 10 keV, where most x-ray research is done. For example, the brightness increase will make it possible to investigate the properties of more complex materials and smaller samples with increased spatial and energy resolution. Site-independent design should begin immediately, and the site selection and construction should commence as soon as possible. If construction were to begin, for example, in FY 87, operation is possible by FY 92.

2. An Advanced Steady State Neutron Facility. The goal is to achieve about ten times the flux of existing machines with a minimum requirement of five times the flux. There are two principal reasons for this recommendation. First, and most important, a high-flux source can be designed to optimize beam geometry and flux distribution, so as to yield greatly increased intensities for all experiments. An increase of about ten times the flux of existing machines is an aggressive but technologically feasible goal. Such a facility would ensure the United States a leading position in this field. This is especially important in the cold neutron range, where flux increases of an order of magnitude can be achieved, providing new capability, for example, for high-resolution spectroscopy and small-angle scattering studies. Second, a new source will be a timely replacement for one or more of our existing sources built in the 1960's. Site-independent design should begin immediately. However, because of safety requirements, the Committee does not expect construction to begin until about FY 89 with completion possibly by FY 96.

3. A 1 to 2 GeV Synchrotron Radiation Facility. This facility would be centered around insertion devices but optimized for the vacuum ultraviolet (VUV) and soft x-ray region. This facility furnishes additional scientific and technical opportunities for research in chemical physics, electron spectroscopy, and imaging techniques such as microscopy and holography.

4. A High-Intensity Pulsed Neutron Facility. Pulsed neutron sources offer new scientific capabilities, especially for investigations requiring higher energy, or greater than thermal, neutrons. Also, there are practical limits to the intensity that steady state reactors can provide. Thus, future improvements in neutron sources, beyond the second priority above, will probably come from alternative approaches, the most promising of which is based on pulsed neutron

sources. However, future action on the construction of a high-intensity pulsed source (about 10^{17} neutrons/cm^2-sec peak flux) should be based upon the results obtained with lower-intensity pulsed sources.

New Capabilities at Existing Facilities

Recent developments make it both practical and cost effective to adapt certain existing user facilities to new purposes by adding experimental halls, instruments, and modified sources. These additions provide an opportunity for new frontier science; they are not simply extensions of existing work.

The Committee's recommendations in order of priority for the addition of these new capabilities at existing user facilities are:

1. Centers for Cold Neutron Research. Guide halls and instrumentation for exploiting the only cold neutron sources in the U.S. located at the Brookhaven National Laboratory and at the National Bureau of Standards, should be developed in an orderly fashion.

There is no cold neutron guide hall in the United States, and such facilities are urgently needed to address the rapid expansion of neutron applications in materials science, chemistry, and biology. Many central problems in these sciences can only be solved using new instruments with cold neutron beams. These centers will enable U.S. scientists to be competitive in cold neutron research during the next decade; and they will provide new instrumentation concepts for developing future neutron scattering sources.

2. Insertion Devices on Existing Synchrotron Radiation Facilities. Insertion devices should be developed in an orderly fashion to exploit about six of the remaining straight sections of existing storage rings. The special characteristics of undulators as radiation sources should be emphasized, to use our existing capability most effectively.

Undulators on existing machines will be our premier synchrotron radiation source for the next 5 years. They will also provide valuable experience for the next generation of synchrotron radiation facilities which will also be based upon undulators. The construction of additional insertion devices, when approved, should follow the construction of new capabilities at synchrotron radiation facilities already included in the budgets for FY 85 and FY 86.

3. Experimental Hall and Instrumentation at the Los Alamos National Laboratory. An experimental hall and new instruments at the pulsed neutron source at the Los Alamos National Laboratory (LANL) would make the United States competitive in pulsed neutron research and would help guide the development of future pulsed sources.

The expected flux increase at this facility is an important opportunity to explore, at modest cost, the great promise of pulsed neutron science for spectroscopic and structural problems.

4. Upgrading of the National Magnet Laboratory. The need for timely development of pulsed magnetic field facilities and instrumentation enhancements at the National Magnet Laboratory has been demonstrated. This laboratory, the only major high magnetic field research facility in the United States provides a unique combination of high fields and low temperatures. Many advances in research depend on its continued development as a dedicated user facility.

5. Enriched Pulsed Neutron Targets. Enriched targets, by exploiting fission events to amplify the neutron flux, can more than double the available flux. The development and installation of enriched targets for use at pulsed neutron facilities would be cost effective.

Priorities 1 and 2 for major new facilities, when they are implemented, would serve as a centerpiece of this nation's future capability for synchrotron radiation and neutron based research. Thus, design and siting studies for a 6 GeV synchrotron radiation facility and for an advanced steady state neutron facility should begin immediately.

Because of the long lead time associated with an advanced steady state neutron facility, the immediate implementation of at least one instrumented cold neutron guide hall is necessary to provide forefront capability.

The basis for these conclusions is expanded upon in the body of the report. Chapter I outlines the characteristics of materials research at universities, at governmental and private laboratories, and in industry, including research styles, research organizational modes, instrumentation, and the role of national facilities. It also offers a brief summary of the status of U.S. facilities vis-a-vis those of other countries. Chapter II outlines scientific and technological accomplishments, using major materials facilities, and suggests the likely direction of future research. It presents the scientific and technological rationale for the recommendations in this report. The Committee's conclusions and recommended priorities for national facilities for materials research and related fields are given in Chapter III.

The Committee again emphasizes that, in response to its charge, its recommended priorities include only synchrotron radiation, neutron scattering, and high magnetic field facilities. Other meritorious materials research facilities were also discussed by the Committee. A number of these are briefly described in Chapters I and III.

I. MATERIALS RESEARCH: FACILITIES AND MODES

Materials research is by its nature interdisciplinary, historically calling on expertise from engineering, physics, earth sciences, and chemistry and, recently, extending to biology and medicine.

In this chapter, we briefly describe the diverse research styles and types of facilities, instrumentation requirements, organizations, and modes of materials research. This is intended to set the context for the focus of the report: major neutron, synchrotron radiation, and high magnetic field facilities, costing in excess of about $5 million. These are all are national user facilities, each serving a group or groups of users whose interests often extend beyond the traditional materials research community. This focus responds to the charge to the committee, as stated in the opening sentences of the Preface and the Executive Summary.

Universities, the federal government, and private corporations are all involved in materials research. In universities, it is done in the main in different disciplinary departments. Within the government, it is done within facilities operated for the U.S. Department of Energy by private contractors, such as the Oak Ridge National Laboratory, the in-house laboratories of the Department of Defense, such as the Naval Research Laboratory, and other laboratories such as the National Bureau of Standards. Numerous industrial laboratories are also involved in materials research, usually in an interdisciplinary mode, ranging in focus from fundamental work to development and manufacturing.

UNIVERSITIES

Much of the materials research in the United States is done in small university laboratories, consisting of a few researchers and a total instrumentation inventory of less than $1 million. Research on this scale continues to provide important, fundamental new science and to train a large fraction of our scientific and technical manpower.

Universities have a crucial role in materials research. They are a major source of new ideas and concepts that often take years to mature, time that industry often cannot commit. And they are the sole source of future materials scientists and engineers. Universities also operate special research facilities that are used by a broader research community.

Training new scientists and engineers for materials research is complicated by the needs of advanced technology for people who are broadly trained and fully conversant across the conventional disciplinary boundaries, such as, for example, condensed-matter physics and chemical engineering.

An important task for the universities is to develop stronger ties with industrial and governmental laboratories. Such cooperative programs stimulate new research, promote the exchange of new knowledge and technology, and help in thecontinuing education of mature technical personnel at industrial and governmental laboratories.

Materials Research Laboratories

The Materials Research Laboratory (MRL) program, supported by the National Science Foundation and the Department of Energy, is intended to stimulate interdisciplinary materials research within universities, of the sort not easily done under the traditional funding pattern of individual research projects. It emphasizes coherent, multi-investigator projects requiring collaboration among individuals in two or more materials-related disciplines. The MRL program has also emphasized the development of wellstaffed and well-equipped central research facilities, partly as mechanisms for stimulating collaboration. Finally, new projects can be quickly started with MRL funding including seed funds to assist both new faculty members and established faculty members with novel ideas or programs who wish to change research fields. MRL core support is not intended as a substitute for individual research project funding, but may properly catalyze significant new research initiatives. Several Materials Research Centers at universities are funded by the Department of Energy and by other agencies. A smaller kind of specialized program, the Materials Research Group, is currently under consideration by NSF.

Instrumentation for Materials Research*

The status of instrumentation in university research laboratories was examined in a 1971 study of the National Research Council (reference 23), commissioned by the National Science Foundation. At that time, a need for $200 million in new instrumentation was identified. Only a small fraction of the need was met at the time, leading to a more problematical situation now. Thus, in the intervening decade, the consumer price index rose by slightly more than a factor of three, while instrumentation costs inflated at almost twice that rate. The accumulated need is now at least $1 billion, and some estimates are considerably higher. The $1 billion estimate is what would be needed to bring university research laboratories up to modern standards and does not include the cost of major new facilities, such as reactors or accelerators. Results from a 1984 National Science Foundation instrumentation survey (reference 24) indicate that only 16 percent of current academic research equipment in the physical sciences could be characterized as "state of the art." Dealing with this crisis in university instrumentation is a matter of national urgency.

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* While this discussion of instrumentation focuses on the needs of the universities, many of the same problems are faced by governmental laboratories engaged in materials research.

Small- and Large-Scale Instrumentation. Exacerbating the shortcomings in university instrumentation is the increasing need for new larger-scale instrumentation for small research groups, instrumentation that is expensive by traditional standards but modest by those of the national facilities. In some cases, the cost of such instrumentation, typically $250,000 to $1,000,000, will necessitate considerable sharing, usually with other investigators or groups at the same institution. Examples include electron microscopes, the new generations of high-powered or very fast lasers, equipment for studying specialized materials, such as molecular beam epitaxy or chemical vapor deposition apparatus, specialized environments such as "clean rooms," very high powered or pulsed magnets, and dedicated 32-bit superminicomputers.

The cost of equipping many experimental stations at large user laboratories is also in this category. For example, most of the beam lines at existing synchrotron radiation facilities now are financed by participating research teams from governmental, industry, and university laboratories. These groups provide their own funding for instrumenting ports to do particular kinds of experiments. It is expected that about half of the additional beam lines proposed in this report for the new and enhanced synchrotron radiation facilities will be funded by the research participants. Future neutron facilities may also be partly developed in this mode.

Large-Scale Computers. Over the past decade, a new and essentially different kind of instrument has been added to the increasingly complex instruments for experimental materials science: the large-scale computer, or supercomputer. Although simple properties of simple systems, such as the cohesive energies of elemental solids, can be calculated within about 10 hours with a 32-bit superminicomputer, calculations for more complex and interesting systems require vastly larger memory and increased computing speed. Greatly increased computing support, during the next 5 to 10 years, would qualitatively affect the usefulness of theory for the solution of materials problems.

Personnel

The need to fully use the facilities discussed here, coupled with the generally complex nature of modern materials research, implies a much more extensive use of technical and professional support staff in individual research groups than has been customary in the chemistry, physics, and materials science communities in universities. Biological scientists in universities are now well established in this mode of operation, as are many physical scientists in industrial and governmental laboratories.

FEDERAL LABORATORIES

The federally supported laboratories have widely diverse roles in U.S. materials science and technology, in keeping with the missions of their agencies. Thus, the national laboratories of the U.S. Department of Energy (DOE) conduct materials research related to the development of nuclear fission, fusion, and other energy sources, as well as to weapons. As do other federally supported laboratories, the DOE laboratories also operate special research facilities that are widely used by the broader scientific community. In fact, the special scientific or measurement capabilities, as well as the major facilities, of the federal laboratories, are the basis for their many cooperative research efforts with industry and universities.

The materials research and development activities of the laboratories of the Department of Defense (DOD) directly support general defense needs or particular weapon systems. Fundamental work in materials research centers on those activities areas inadequately addressed by the private sector or activities that may have an important long-range impact on the scientific or technological needs of future defense capabilities. Overall, the DOD laboratories can engage, when it is necessary, in all aspects of materials research and development, from fundamental concepts to providing prototypes. Finally, the direct role of the DOD in materials research is complemented by its indirect role in broadly supporting contract R&D at academic, industrial, and governmental laboratories of other agencies.

Other governmental departments and agencies also have major roles in materials research. For example, one of the central missions of the National Bureau of Standards, within the Department of Commerce, is research leading to new or improved measurement methods and standards and to basic understanding of the properties of materials needed by industry, universities, and government. The U.S. Geological Survey, within the Department of the Interior, has a major effort in basic and applied materials research related to the nation's mineral resources.

INDUSTRY

Condensed matter science is unusual in that a significant portion of basic research in the U.S. is performed in industry. This reflects the fact that condensed matter science supports advanced technologies in many areas of national priority, including those of information systems, energy, health, transportation, and national security. Basic industrial research is conducted in all sub-areas of condensed matter science using many modes, ranging from the individual researcher to research groups. Industrial researchers also make active use of national facilities and collaborate in these efforts with university and governmental researchers. Multidisciplinary materials research is often carried out effectively at the major U.S. industrial research laboratories.

In addition to playing a major role in basic materials research, industry also helps define the future materials needed to advance important key technologies. That, in turn, serves as a guide to research at university and governmental laboratories as well as at industry laboratories.

The largest materials research effort in the U.S. undoubtedly is the industrial research and development effort focused upon product lines. Because this effort often requires advanced applications of materials for specialized uses, it generally requires a fundamental understanding of materials. The availability of university-trained scientific and technical personnel is essential for this extensive industrial research and development. Collaboration by industry researchers, with scientists and engineers at both university and governmental laboratories, contributes substantially to technology transfer. Recently, specialized facilities, such as microelectronics-related facilities, have been created at universities to address both basic research and the technology needs in industry.

MAJOR MATERIALS FACILITIES

Within the above perspectives on the diversity and range of facilities and practioners of materials research, the Committee describes below the status of several major materials facilities in the United States. These facilities are more fully described in a recent review article (reference 22).

Synchrotron Radiation Facilities

The synchrotron radiation facilities in the United States today range from small, virtually in-house facilities to large user facilities. The Cornell High Energy Synchrotron Source (CHESS) is a laboratory using a 5.5 GeV storage ring parasitically. The six end stations serve about 250 users annually. The National Synchrotron Light Source (NSLS) at the Brookhaven National Laboratory has two storage rings, 0.75 and 2.5 GeV, dedicated to the use of synchrotron radiation. Approximately 58 end stations, including those in a current upgrade program, serve a growing user community, currently estimated at 400 scientists annually. The Synchrotron Radiation Center (SRC) at the University of Wisconsin, currently operates a 0.24 GeV storage ring and is commissioning a 0.75 to 1.0 GeV ring. The 20 beam lines on the latter serve an estimated 150 users annually. The Stanford Synchrotron Research Laboratory (SSRL), at the Stanford Linear Accelerator Center, uses a 3.5 GeV storage ring dedicated to synchrotron radiation part of the year and in a parasitic mode the rest of the year. Counting beam lines in a current upgrade program, the 19 end stations serve a user community of 300 scientists. In addition, one undulator beam line is to be built on a 15 GeV storage ring at the same site.

The Synchrotron Ultraviolet Radiation Facility (SURF), at the National Bureau of Standards, is a 0.24 GeV ring dedicated to synchrotron radiation use. Its 13 beam lines serve about 40 users annually. Expanded descriptions of these facilities and a definition and history of the user community, as well as its characteristics, can be found in two previous reports (references 5, 8).

Of the storage rings listed above, only three--two at NSLS and one at SRC--were designed to be sources of synchrotron radiation, and those three were all designed prior to a full recognition of the importance of insertion devices. Consequently, they were designed to emphasize the radiation from the bending magnets, with capabilities for the later addition of a limited number of insertion devices. (For a description of insertion devices, see Chapter II and references 5, 8, 18, 19, 20, 26.)

Foreign Synchrotron Radiation Facilities. Many synchrotron radiation facilities exist elsewhere, offering strong competition to U.S. scientists. These are extensively described in other reports (references 5, 8). The principal operating sources are in England (SRS), France (ACO, super ACO), West Germany (HASYLAB, BESSY), Japan (Photon Factory), and the USSR (VEPP-3, VEPP-4). There are other facilities in some of these countries, as well as in Italy and Sweden. Construction is under way for facilities in the People's Republic of China, and there are plans for facilities in Taiwan, India, and Brazil. None of the facilities mentioned above is more advanced than our newest facilities, NSLS and SRC. However, the European Science Foundation is planning to build a 5 to 6 GeV storage ring very similar to that proposed for the United States.

Neutron Scattering Facilities

There are, currently, active neutron scattering programs at five different national centers: Argonne (ANL), Brookhaven (BNL), Los Alamos (LANL), National Bureau of Standards (NBS), and Oak Ridge (ORNL). The BNL, NBS, and ORNL facilities center around steady state reactor sources, while ANL and LANL involve pulsed spallation sources. There are also reactor based neutron scattering programs at the University of Missouri, the Massachusetts Institute of Technology, and other universities. This section focuses on the national centers for neutron research.

The BNL facility centers around the 60 MW High Flux Beam Reactor (HFBR), which has a thermal flux of 1 X 10^{15} neutrons/cm^2-sec. It is equipped with eleven spectrometers and diffractometers, with two more under development. The NBS facility has nine end stations, with a tenth under development. A cold source has been installed on the BNL reactor, and funding has been provided for installation of a large volume cold source in the NBS reactor. The ORNL facility centers around the 100 MW High Flux Isotope Reactor (HFIR), which has a thermal flux of 1 X 10^{15} neutrons/cm^2-sec. It is equipped with nine scattering instruments, with a tenth under development. The instruments include a 30-meter small-angle scattering instrument that is funded by NSF as a national user facility. The ANL facility centers around a pulsed neutron source that produces bursts of neutrons with a peak thermal flux of 4 X 10^{14} neutrons/cm^2-sec at a 30 Hz repetition rate. It is now the most intense pulsed source in the world, equipped with eight instruments, with a cold moderator available for several beams. The LANL facility centers around a pulsed spallation source that, by 1986, will provide a peak thermal flux of about 1 X 10^{16} neutrons/cm^2-sec at 10 Hz. Six beam lines are now available, with two instruments operating in the user mode. Ten or more beam lines will ultimately be developed.

All of these centers have ancillary equipment, enabling one to study samples in varied environments with temperatures from 0.3K to 1800K, pressures up to 20 kbar, and magnetic fields up to 80 kG. There is extensive research by outside users at each center, with the individual center user programs varying from informal collaborations to a formal peer-reviewed process. In most cases, outside user experiments involve collaboration with in-house people.

Aside from the facilities described above, there are efforts at the various neutron centers to develop area detectors, multilayer polarizing monochromators, focusing collimators, and neutron choppers and polarizers, all of which are important for developing advanced instrumentation for reactor or pulsed sources. These efforts, in general, have a low-to-modest level of support and manpower compared with instrumentation projects in Europe, discussed below.

Foreign Neutron Scattering Facilities. This subsection offers a selective review of foreign neutron scattering facilities, concentrating on instrumentation developments particularly in Western Europe that have not been matched in the United States. An important key to the European success, especially at the Institut Laue Langevin (ILL), has been the development and use of cold neutron sources and associated guide halls to create instruments for ultra high-resolution and high-sensitivity spectroscopy. These currently provide energy resolutions as much as five orders of magnitude better than those available in the United States; they also enable studies of small-angle and medium-resolution diffraction and other new scientific applications. As already noted, there is only one cold neutron reactor source in the United States, at BNL, and another under development, at NBS.

The United States has no guide halls to improve the versatility and flexibility of cold or thermal neutron instruments. In contrast, 60 percent of the neutron scattering instruments at the ILL (reference 7) are located in a large guide hall, and a new guide hall and cold source are to be completed over the next 2 years. Also, there are major efforts at ILL to develop and construct focusing monochromators, polarizing devices, reflecting supermirrors, environmental control systems, dedicated instruments for diffraction surveys using neutron cameras, and more. Besides the ILL program, there is a new reactor center, called Orphee, at Saclay near Paris, with two hydrogen cold sources, which will ultimately commission over twenty new instruments for neutron scattering and fundamental physics research. Expanded guide halls with many new instruments are also under construction at the KFA Research Reactor in Julich and at the Berlin reactor. Finally, the Japanese government has approved funding for the complete modernization of the JAERI III Reactor at a cost of $150 million, including a replacement of the vessel, an upgraded fuel and beam tube arrangement, and installation of a large cold source and guide hall.

The total current operating expenditures for neutron scattering at research reactors in Western Europe is about $80 million per year, in FY 83 dollars, including associated reactor operation costs, roughly triple the U.S. effort. An order of magnitude difference emerges when one compares capital investment for new spectrometer development and construction efforts. The consequences of this investment gap over the past decade between European and U.S. research reactors are being felt increasingly in our inability to compete in many areas of new science involving such techniques as high-resolution neutron spectroscopy, small- and medium-angle diffraction, and diffuse scattering.

The current U.S. position in pulsed neutron research and development is better in relative terms with respect to foreign competitors than for steady state sources. For example, the Intense Pulsed Neutron Source (IPNS) at Argonne is presently the highest intensity facility in the world, and the Weapons Neutron Research/Proton Storage Ring (WNR/PSR) at Los Alamos is scheduled to provide, by 1987, an order of magnitude increase in intensity for pulsed neutron experiments.

However, developments abroad make current comparisons misleading. For example, the SNS advanced spallation source under construction at the Rutherford Laboratory in Britain, which is scheduled to be brought on line by the end of 1984, will have neutron intensities 2 to 3 times the current IPNS performance and will, by 1986, generate a peak thermal flux of 5×10^{15} neutrons/cm^2-sec at a 50 Hz repetition rate. That is roughly twice the total intensity of the scheduled WNR/PSR source. This facility will ultimately have a complement of at least 15 neutron scattering instruments. Moreover, the Japanese, who have developed a modest flux facility at Tsukuba with an impressive array of instruments, are also funding a planning and design study for a major new pulsed source, costing $100 million in FY 83 dollars, which would slightly exceed the characteristics of the SNS at the Rutherford Laboratory.

User Policy at Major Materials Facilities

Since major materials facilities are intended for a large community of scientists, it is very important that they be available to all qualified research investigators with meritorious proposals. A number of approaches have been used in the past to arrange participation, each having strengths and weaknesses. Some perspectives and generalizations from experiences to date are given below to help guide the formulation of future policies.

Criteria. There are several extant models of user policies for major neutron and synchrotron radiation facilities. In general, they satisfy the following generic criteria:

1. Experimental activities, except for construction and maintenance, whether they are initiated by research staff of the facility or by outside scientists, are presented and justified in written form. The proposals are reviewed before research is authorized and begun.
2. Committees reviewing proposals include a substantial fraction of scientists from outside the facility.
3. Priorities are established by the facility director based on ratings of the review committee and on scheduling considerations. The director has the discretion to provide for the insertion of experiments to exploit blocks of instrument time that are freed by unanticipated events.
4. Use of a facility is not restricted to U.S. scientists, but priority may be given to them in the event of equivalent proposals.
5. The time assigned for an experiment is designed to be adequate for the measurements, but extensive, repetitive, or confirmatory measurements may require the submission of additional proposals.
6. Some fraction of instrument time should be made available for use by the director at his or her discretion. This time can be used to extend assigned periods for current experiments, to permit preliminary experimentation in advance of a proposal, and for instrument development. Approximately 20 percent of instrument time is suggested for such purposes.
7. Users should be provided with an adequate level of technical support at the instrument so that they can safely and efficiently conduct experiments. Vacuum interlocks, shielding, and other safety devices should be controlled by facility management. The design of user facilities should make it impossible or difficult for any user at one port to affect the beam delivered to any other port.
8. The facility should provide a stock of standard test instruments, normal electronic and vacuum components, cryogenic fluids (liquid nitrogen and helium), data acquisition computer systems, commonly used gases, and some minimum storage space for user owned equipment.
9. It should be recognized that there are a range of user interactions. Some users will make very short-term and straightforward measurements, others will do long-term, interactive experiments in

which protocols and parameters are altered as the experiment proceeds. The different needs of these groups should be considered in designing facility user policy.

Participating Research Teams. A concept that has been used successfully in several major facilities is that of the participating research team, or PRT. This is a group of individuals who take communal responsibility for the design, construction, and operation of an instrument at an existing port. The PRT may also be responsible for organizing funding for the instrument. Industrial, university, and governmental groups have formed PRT's. It is a concept that appears to provide a reasonably successful approach to using facilities.

The principle is that, for a specified period--2 to 3 years, for example--the PRT has some 75 percent of the running time for that port, outsiders being allocated 25 percent. This has the advantage that the management of each instrument becomes much more flexible for members of the PRT, and more effective science may therefore be done. An important responsibility of the PRT's is to provide help for outside users. By augmenting the local staff in this manner, the entry barrier for naive users can be reduced. In some cases, PRT's are reviewed every 3 years for possible renewal; involvement with outside users is an important consideration in such renewals. A PRT is responsible for maintaining the instrument. If the PRT does not find its own outside users through collaborations, the facility director can assign an outsider to use the PRT's line during the open time.

Maximal use of a facility may involve a mixed mode operation in which some beam lines are operated by PRT's and some by the facility. The consequent flexibility of operation at the scientific level justifies the administrative complexity of such an arrangement.

Whatever the user policy, the experience to date indicates that it is important to keep the level of bureaucracy as low as possible, even if there is some loss of efficiency in using the instrumentation. This criterion tends to conflict with that of extensive peer review of lengthy proposals by potential users, so some balance is called for.

A mixed mode operation in which a facility has participating research teams and provides instruments seems an appropriate balance. It is not the intent of the Committee to spell out a rigid user policy for future major materials facilities. Any proposals for a new facility, however, should include a well-considered plan for utilization, taking into account the considerations mentioned above. The aim, of course, is to create user policies that permit the best science in an atmosphere of equal opportunity for different users.

II. MAJOR MATERIALS FACILITIES: SCIENCE AND TECHNOLOGY

Condensed-matter science, or materials research, deals with the diverse properties of solids and liquids and their interfaces. It is interdisciplinary, involving materials science, including metallurgy, ceramics, polymers; major subareas of physics and chemistry; as well as the earth sciences, biology, and medicine. Interest in materials research derives from fundamental science and technology. It is an intellectually stimulating area of science, as shown by the discoveries of fundamentally new phenomena, concepts, and states of matter during the past decade. Indeed, several recent Nobel prizes have been awarded for research in condensed-matter science.

Condensed-matter science supports advanced technologies in areas of national priority, including those of information systems, communication and computers, energy, health, transportation, and national security. Products of condensed-matter science, such as the transistor and the integrated circuit chip, have revolutionized our lives through their use in television, calculators, electronic watches, personal computers, appliances, autos, and innumerable other applications. In Table II.1, the Committee summarizes the connection between subareas of materials research using major facilities and technological applications.

SYNCHROTRON RADIATION, NEUTRON SCATTERING, AND MAGNETIC FIELDS

The spectroscopic analysis of matter involves bombardment with particles, such as neutrons or photons, with or without energy changes, or the use of high magnetic fields. The sensitivity that can be achieved is limited by the intensity of the radiation or the strength of the field.

Neutrons

The neutron is a unique probe that interacts weakly with atomic nuclei. The magnetic moment of the neutron makes it especially suited for examining magnetic properties of materials. By measuring changes in the

Table II.1. Connection Between Materials Research Subareas and Other Fields that Utilize Major Materials Facilities and Technological Applications of National Interest

	Information Systems (computers, communications, electronics)	Energy (fossil, nuclear, fusion, solar,...)	Health (Medical, Biotechnology, Environmental)	National Security	Transportation (ground, air, space)
Semiconductors	+	+	+	+	+
Metals and alloys	+	+	+	+	+
Insulators	+	+		+	+
Polymers	+	+	+	+	+
Ceramics	+	+		+	+
Magnetic Materials	+	+	+	+	+
Catalysts		+	+	+	+
Adsorbates		+	+	+	+
Lamellar (layered) materials	+	+		+	+
Composites		+	+	+	+
Biological molecules, macromolecules, and membranes			+		
Gaseous molecules and atoms	+	+	+	+	+
Plasmas (atoms, ions)		+	+	+	

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* In addition to bulk materials, thin films, interfaces, and surfaces of several of the above materials are of major scientific and technological importance.

momentum and energy of neutrons scattered by matter, direct information can be obtained on the structure of matter as well as its states of excitation.

For example, neutrons slowed to relatively low velocities--"cold neutrons"--have been used to "look" at the shapes of molten polymers. The technique is based on the fact that hydrogen and its heavier isotope, deuterium, scatter neutrons differently. Polymers are prepared in which hydrogen atoms are replaced by deuterium; isotope substitution does not alter the molecular configuration. Thus, when two polymers--ordinary and deuterated--are then exposed to a beam of cold neutrons, the actual size and configuration of the polymer can be deduced by comparing the different forms of neutron scattering from the two polymers.

Increased emphasis on research using cold neutrons is dependent on the availability of "guide halls," which are large experimental areas in which high resolution neutron spectrometers can be placed. This is possible because of the development of "guide tubes," which allow the neutrons to be transported many meters to the guide hall without significant loss of intensity.

Neutron beams can be either continuous or pulsed. Continuous beams are obtained from nuclear reactors, using controlled nuclear fission of uranium surrounded by suitable neutron moderators and reflectors, such as D_2 and beryllium. Pulsed neutron beams are generally produced from short bursts of high energy protons or electrons from an accelerator impinging on a heavy metal target, such as uranium or tungsten, to generate bursts of very high energy neutrons. This target is surrounded by a moderator-reflector assembly that is analogous to, but generally smaller than, that in a reactor, so that relatively short bursts of thermal and fast neutrons are produced at rates of 10 to 100 pulses per second.

Synchrotron Radiation

Synchrotron radiation is a unique source of photons, by virtue of its high intensity, brightness, stability, and broad energy range, extending from the far infrared to the x-ray region and beyond. It is created when charged particles within an electron accelerator are deflected by a magnetic field. The intensity of the synchrotron radiation can be further increased with the use of insertion devices. The simplest of these is the wiggler magnet that puts a relatively sharp kink in the electron trajectory of the synchrotron, thus increasing the radiation from that point. A more sophisticated device called an undulator in effect puts in a series of kinks so arranged that the light from each adds up in phase, giving an enormous increase in the intensity that can be achieved. Although synchrotron radiation represents a drain of energy in an accelerator, it was eventually recognized to be a source of intense radiation for new classes of experiments, first in solid state physics and then in other sciences.

Measurement of the momenta and energy of synchrotron-produced photons, which interact strongly with electrons, provides information on structure and excitations. Such excitations range from molecular vibrations, measured in the infrared, to the ejection of electrons from the innermost electron shells of atoms by photons in the x-ray region of the spectrum.

Such capabilities are very important for many fields. For example, synchrotron radiation is a major tool in probing the geometry and electronic structures of surface and solid-solid interfaces. In particular, photons from synchrotron radiation are used for photoelectron spectroscopy, in which electrons are ejected and their energy and angular distribution then measured.

Magnetic Fields

High magnetic field research is important for the fundamental understanding of a broad range of materials properties. Scientific advances in such diverse areas as superconductivity, permanent magnet research, and semiconductor science, all benefit from research based on the availability of intense magnetic fields. The attainment of such fields is ultimately connected to useful applications, development and industrial commercialization. Each time a higher magnetic field strength is achieved, it is quickly exploited by the scientific community and is accompanied by a requirement for yet higher field strengths. This new demand often requires a combination of high fields and low temperatures, or the combination of high magnetic fields with ancillary measuring equipment such as precision optical systems.

Superconductivity is the research area most strongly linked to high magnetic fields. An understanding of superconductors, which could form the basis for new and improved high field magnets, depends upon experiments carried out in some of the highest available fields. Therefore, the availability of present-day high field facilities is closely linked to the development of future facilities. High magnetic fields are also essential for probing those fundamental properties of superconductors that can be used to test microscopic theories, including theories based on the concept of electron pairing.

Basic Principles And New Problems

Against this background, it should be recognized that a family of basic principles and techniques underpins the field of materials research. Some of these have already been well exploited and are well understood. For example, the existence of lattice vibrations of short wavelength in metals was settled decisively with the use of neutrons some 25 years ago. Likewise, the electron energy band dispersions of solids and surfaces have been determined directly using photoelectron spectroscopy. Extended X-Ray Absorption Fine Structure (EXAFS) has been employed extensively to determine site-specific atomic structure for parts-per-million impurity concentrations and adsorbates. However, the applications of x-ray and neutron scattering to biology and polymer science, as well as to other aspects of materials science, are just beginning.

Effective, increased use of such techniques for improved understanding of fundamental biological processes will require the establishment of additional mechanisms for bridging between physical and biomedical scientists.

As theoretical concepts and processes for synthesizing materials advance, new problems come to the fore. Many involve the acquisition of detailed information regarding structural and dynamic properties that can be provided with the techniques employing neutron scattering, synchrotron radiation, or strong magnetic fields. Although it is impossible to forecast exactly how these techniques will be used to solve such problems, the Committee can predict confidently that there will be new problems a decade from now that will be especially amenable to approach with the equipment available at major materials facilities. The value of having equipment with advanced capabilities available to solve as yet barely discernible problems should not be underestimated. To indicate the breadth of applicability of such facilities, a partial list of available techniques is summarized in Table II.2.

Many problems that are well defined now cannot be explored adequately because the appropriate instrumentation or facilities are not available in the United States. Examples include the determination of the dynamics of intercalate species in single crystals of intercalated graphite having semiconducting properties. This problem can be approached using neutron scattering, along with nondestructive determinations of the concentration of electronic impurities in the range of 0.1 ppm using an x-ray microprobe.

In the following sections we discuss areas of science in which new major materials facilities can be expected to make further important contributions. More extensive summaries are described elsewhere (references 1, 2, 5, 7, 8, 18, 20).

SYNCHROTRON RADIATION RESEARCH: PAST AND FUTURE

Research with synchrotron radiation began in the 1960's and has grown dramatically in the past decade. Whenever a synchrotron radiation facility offering an increase in brightness, typically by a factor of from 10 to 10,000, became available, new types of research became possible. Furthermore, experiments carried out with such new equipment have usually demonstrated how new science could be developed if still higher brightness was available.

Four Generations

We have gone through three generations of such increases in brightness; the fourth is at hand. The first was associated with synchrotron radiation from the bending magnets of storage rings built for particle or nuclear physics. The second came with the construction of new storage rings specifically intended to produce synchrotron radiation (reference 1). These are now in operation or soon will be. The third emerged with the realization that insertion devices, wigglers and undulators

TABLE II.2. Techniques Available at Synchrotron Radiation and Neutron Facilities

	Neutrons	Photons	
		X-ray	Soft X-ray and VUV
I. Elastic scattering*			
Bulk crystallography	x	x	
Surface crystallography	x	x	
Molecular cystallography	x	x	
Small angle scattering	x	x	
Polarized scattering	x		
Magnetic scattering	x		
Diffuse scattering	x	x	
II. Quasielastic scattering			
Diffusion	x		
Reorientation	x		
Critical dynamics	x		
III. Spectroscopy and elemental analysis			
Inelastic (E,k) scattering			
- electrons		x	x
- phonons	x		
- magnons	x		
Absorption, reflection, fluorescence		x	x
Absorption spectroscopy			
- EXAFS		x	x
- SEXAFS		x	x
- PHD		x	x
Photoelectron spectroscopy			
- core level		x	x
- valence level		x	x
- ARPES		x	x
- yield spectroscopy		x	x
Photon stimulated desorption			x
Photo chemistry		x	x
Activation analysis			
- thermal neutron activation	x		
- prompt γ-ray	x		
- fast neutron activation	x		
- nuclear track	x		
IV. Imaging and microscopy			
Microscopy			x
Microprobe		x	x
Depth profiling	x	x	
Topography	x	x	

TABLE II.2 (continued)

		Photons	
	Neutrons	X-ray	Soft X-ray and VUV
IV. Imaging and microscopy (continued)			
Lithography			x
Interferometry	x	x	
Radiography	x	x	
Autoradiography	x		
Holography			x
V. Radiation effects			
Radiation damage	x	x	x
Isotope production	x		
Transmutation doping	x		

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* Many of the elastic and inelastic scattering techniques can be time resolved and/or spatially resolved with increased resolution and usefulness as the brightnesses of future sources are increased.

(see references 5, 8, 17, 18, 19), would enhance the intensity of synchrotron radiation. These devices have been, and are being, added to the present generation of storage rings, although not yet to the maximum possible degree. Unfortunately, the appreciation of the role insertion devices could play came too late to influence in any major way the design and construction of our present generation of storage rings.

The fourth generation of synchrotron radiation facilities, now technologically possible, involves the construction of new storage rings designed to maximize the brightness of the radiation from insertion devices. Such rings offer brightness increases by factors of from 50 to more than 100 over the best synchrotron radiation sources we have today or that we can achieve by adding new insertion devices to existing facilities. No dedicated facility that can produce undulator quality radiation in the x-ray region exists at present. Using the orders of magnitude increase in brightness that will be achieved with a new 6 GeV facility, we will be able to conduct entirely new types of experiments, some of which will open up major new research areas.

Synchrotron radiation has already contributed to many aspects of materials science as well as to other fields. Some of the more important contributions are outlined below. More extensive descriptions may be found in references 5, 8, 18, and 20, and in the references therein.

The simplest experiment, and one of great importance, centers about the measurement of photoabsorption by atoms, molecules, and solids. The continuum of synchrotron radiation allows easy access to the core levels of many atoms and has revealed a variety of many-body phenomena, including giant collective resonances, so-called Fano (interference) line shapes, "missing" spectral lines, and the "spike" shape of some absorption edges in metals. These have contributed to a better understanding of many-body effects in both atoms and solids.

At energies above the absorption edges in solids, the extended x-ray absorption fine structure (EXAFS), which is produced by interference effects in the scattering of the ejected core electron, gives precise information concerning the local geometry of the absorbing atom. When increased brightness is available, the EXAFS technique can be extended to detect elements in bulk samples and submonolayer adsorbates on surfaces that are present in concentrations of parts per million. EXAFS gives site-specific, geometrical information regarding atoms in samples of many types, such as alloys, catalysts, and biological molecules. In most cases, the structural information obtained with the EXAFS technique was unattainable previously. Examples include geometrical information concerning the active site of the important nitrogen-fixing enzyme, nitrogenase; information relative to the active sites of important catalysts; structural parameters of impurities in coal and oil that make processing difficult; and studies of the role of impurities in determining important mechanical properties of materials.

Photoemission spectroscopy is widely employed at synchrotron radiation facilities. It provides independent information on initial and final electron states. Moreover, the anisotropy exhibited by atomic and molecular photoemission spectra gives information concerning atomic wave functions that is different from that obtained from absorption spectra.

Photoemission from molecules exhibits shape-dependent resonances that are studied in the gas phase and then used to determine the orientation of molecules on surfaces. The continuum of synchrotron radiation makes possible various forms of so called "yield spectroscopy," in which the absorption of photons is signalled by secondary events. In this way, one can, for example, selectively examine absorption in the region of a surface by monitoring the yield of Auger electrons. Similarly, one can determine the onset of bulk absorption by monitoring the emission of characteristic x-rays. Brighter synchrotron radiation sources have permitted angle-resolved photoemission experiments that give electronic band structure, including symmetry, directly from the data. These experiments yield fundamental energy band information for solids, surfaces, and adsorbates, and thereby provide the basis for a more complete understanding the electronic properties of matter.

While EXAFS and photoemission spectroscopies have been pursued since the advent of x-ray and VUV synchrotron radiation based research, x-ray scattering and direct imaging technologies are just beginning to be carried out with the newest generation of insertion devices and storage rings. In spite of the limited time in which they have been available for exploration, these facilities have already shown that they can be used to obtain significant results. This gives us confidence that research based on synchrotron radiation will benefit dramatically from the next generation of facilities employing insertion devices. The scattering of x-rays by monolayer adsorbates and freely suspended thin films that are two monolayers thick has already been successfully demonstrated. In addition to opening the techniques of x-ray crystallography to the world of surfaces, thin films, and interfaces, synchrotron radiation has permitted exploration of the scientifically important phenomena associated with two-dimensional phase transitions.

The increase in intensity offered by the newest storage rings has enabled the study of bulk crystals that are as small as 1 m in size, thus permitting the determination of the structure of many important materials, such as synthetic zeolites, that can only be grown in the form of very small crystals at present. The use of anomalous x-ray scattering promises to help solve the difficult problem of determining scattering phases that has plagued crystallographic studies of important large macromolecular systems. The pulsed nature of synchrotron radiation has been used successfully to study the technologically important process of laser annealing of silicon as well as the scientifically important problem of muscle action in animals. The initial experiments in which synchrotron radiation is used for angiography have shown real promise of improving this medically important diagnostic procedure dramatically (reference 8).

Summing up, the first three generations of synchrotron radiation have already provided us with a revolution in the capabilities for using photoemission and EXAFS techniques and have demonstrated great promise for employing scattering and imaging to advance many areas of science and technology. Insertion devices, particularly undulators, will advance the areas approachable with the use of photoemission and EXAFS techniques further and provide dramatic new opportunities for scattering and imaging.

The topics described above indicate what can be done with the newest sources of synchrotron radiation. More important are the even more complex research problems that can be undertaken with new storage rings that are designed specifically to use insertion devices. Examples are given below.

Condensed-Matter Physics

A major fraction of research using synchrotron radiation, both x-ray and soft x-ray, has involved the field of condensed-matter physics. There is a large number of new applications that cannot be addressed because of limitations of sources or instrumentation, or both.

Photoemission Spectroscopy. Photoemission spectroscopy is the primary technique for studying the electronic structure of solids, surfaces, adsorbates, and interfaces. On the basis of experiments being carried out at the new synchrotron radiation facilities, we can foresee what can be done with yet brighter sources. Angle-resolved photoemission provides understanding of the electronic band structure, including the band structure of the surface. The sample may be a crystal or an ordered overlayer. The resolution of angular and energy distributions has been increased with sources of higher brightness and have revealed new structures. Additional resolution is mandatory for the study of any material with a large unit cell, either in the interior or on reconstructed surfaces. Recently, measurements of spin-polarized photoemission have been carried out with synchrotron radiation. When combined with angle resolution, this procedure allows determination of the band structure of magnetic materials, including the spin labels for the bands. This is a technically difficult experiment. In particular, polarization detectors are notoriously inefficient. Brighter sources are mandatory if this technique is to be used widely.

At higher photon energies, one enters the region of x-ray photoemission in which the binding energies of core levels and the density of states for the valence electrons may be probed. Commercial equipment for this type of measurement with a resolution of approximately 0.5 eV at fixed photon energies is available. A synchrotron radiation source of the next generation would offer both higher resolution and higher sensitivity than anything possible today, thereby improving the utility of this already useful spectroscopy. Of perhaps greater significance is the extension of photoemission spectroscopy to procedures providing time and space resolution. This would make it possible to study surface reactions and to carry out microprobe studies of photoemission.

Surface Science. Other techniques for the study of surfaces also are benefitting from higher brightness sources. One is surface EXAFS, in which an absorbed x-ray excites a surface atom or molecule and a fluorescent x-ray or an Auger electron is then detected. The spectra give precise geometrical information on the location of the surface species. Photoelectron diffraction gives similar information. Both these techniques provide gains in surface sensitivity as the source brightness increases, and allow the study of surface species at ever great dilution. Finally, the new areas of photon-stimulated desorption of species from the surface requires sources of higher brightness. Both neutral and charged atoms and molecules, in their ground and excited states, can desorb from surfaces during photoabsorption. This may be the most site-specific surface phenomenon known. The photon flux used must be high because of the possibly small number of desorption sites and the low probability of release.

X-ray Scattering. X-ray sources of higher brightness are ushering in a new era in x-ray scattering. One can now work with surfaces, thin overlayers, and even freely suspended membranes. The crystallography of reconstructed surfaces can be determined, as can that of monolayer adsorbates. Thus, the crystallographic technique responsible for determining most of the known bulk structures can be extended to surfaces and thin films with insertion devices. This can be done as a function of temperature, to follow the structure and dynamics of quasi-two-dimensional melting. In fact, the study of phase transitions in two dimensions is providing important tests of theories of the behavior of the two-dimensional world of surfaces and thin films. Magnetic x-ray diffraction has been observed recently on the 54 pole wiggler at Stanford and promises to be comparatively routine when the brightest available x-ray wiggler sources can be used. Magnetic diffraction can provide much information concerning the magnetic structures of solids when an x-ray undulator on a 6 GeV source is available, and thus will complement traditional neutron studies, especially for materials for which only small samples are available. In some cases, surface magnetism may also be studied.

Inelastic X-ray Scattering. One field almost completely neglected in the first three phases of the evolution of synchrotron radiation has been inelastic x-ray scattering as related to the dynamic properties of the system being studied. The brightness of the radiation is most important for such research. Inelastic scattering of x-rays can, in principle, be used to probe both the electronic properties, such as those of plasmons, as well as collective atomic properties, such as lattice vibrations. However, achieving the 10^{-2} to 10^{-3} eV energy resolution needed will require the brightness provided by insertion devices and by major new instrumentation.

Atomic and Molecular Physics and Chemistry

Gas-phase photoemission has contributed extensively to our knowledge of atoms and molecules. Early studies emphasized the "static" study of excited states, the decay channels being inferred from line shapes. As the brightness of sources increased, the decay products, such as ions, electrons, and photons, could be detected. Finally, coincidence experiments began to be carried out, leading to more precise information regarding the nature of the excited states. Gas-phase experiments always require high brightness sources, for the sample is necessarily dilute.

The next-generation sources will permit several new classes of experiments. We already can work with gases at high enough resolution to excite single vibronic levels in molecules. These excited states can then be probed by high-resolution laser-spectroscopic techniques. Moreover, when source brightness becomes adequate, a molecule in an excited state can be made to interact with another molecule, bringing in an era of state-to-state photochemistry. These experiments are not possible with present sources because none have adequate brightness. Moreover, the time structure is not favorable.

The next-generation source will have pulse lengths shorter by a factor of about five relative to those now available. Such time structure will permit fluorescence spectroscopy from excited states on a time scale of a few picoseconds--shorter than the radiation pulse itself. This capability will, for example, make it possible to determine structural and dynamic properties of large molecules in solution and to study atomic and molecular reactions on surfaces. It will also be possible to use molecular beam techniques.

Biology and Medicine

EXAFS and x-ray crystallography involving synchrotron radiation have been applied to biological systems in the past. EXAFS has been useful for obtaining detailed information on large biomolecules such as hemoglobin. It is especially useful for molecules with a functionally important minority constituent, such as a metal atom in an enzyme. With increasing source brightness, it is possible to work with larger molecules having fewer active elements per unit volume. Time-dependent studies in which the structural response of the active site in the molecule to a chemical perturbation is determined become possible. Time-dependent x-ray absorption spectroscopy has already been used to follow the Fe absorption edge as the iron in myoglobin recombines with CO after laser-induced flash photolysis of carboxymyoglobin (references 25, 26). This was done on a 300 sec time scale with an existing storage ring. Better time resolution is possible, but EXAFS measurements on such a time scale await a source with higher brightness.

In studying x-ray damage to biological molecules and crystals, it has been found recently that the reciprocity law breaks down, and less damage results if the radiation dose is delivered at high rates for a short time. Therefore, higher-brightness sources offer the opportunity to work with smaller crystals, including those of molecules difficult to crystallize. They also make it possible to collect more data before samples become so badly damaged as to impair resolution.

Element-specific imaging represents the principal foreseeable application of synchrotron radiation to medicine. One form of coronary angiography used today involves the imaging of the coronary arteries in real time by K-edge absorption of iodine which is added to the blood. The classical technique is invasive, and provides relatively low resolution. In-vivo angiographic studies of animal hearts with synchrotron radiation are noninvasive, fast, and provide higher resolution. Studies on human hearts are planned and, if they are successful, should provide novel approaches to studies of atherosclerosis and, eventually, to clinical applications. A high-field wiggler would represent the only foreseeable source for such work with present machines, but bending-magnet radiation from a 6 GeV ring could facilitate applications of this technique.

Earth Sciences

The earth sciences provide opportunities for the application of synchrotron radiation in connection with microprobe analysis. Such analysis is now carried out with electron microprobes. Synchrotron radiation can also be used in x-ray diffraction studies at high pressures. A principal need is for structural characterization of minute crystals and zoned, or multi-domained, larger crystals. Higher brightness than is now available will benefit such research.

Imaging and X-ray Microscopy

There are several methods for achieving element-specific imaging, all at a relatively primitive stage of development. These include microprobe analysis, microscopy with zone-plates, and contact "lithography." As source brightness grows and the coherence of the radiation from soft x-ray undulators increases, microscopic holography and soft x-ray diffraction will become feasible. Both processes promise to give three-dimensional images of microscopic biological elements with a spatial resolution down to about 50 Angstroms. Available new sources will allow demonstrations of these techniques, which can be applied to study phenomena within a single cell. An undulator on a next-generation storage ring will make it possible to carry out useful and wide-ranging studies on such systems, employing radiation that "sees" only one element at a time.

Electron microscopy cannot be applied readily to living cells. However, holographic imaging techniques may make it possible to work with living cells, or at least with cells that have been processed less than is now the norm in electron microscopy. The imaging can be carried out on a millisecond time scale and with submicron resolution. The source needed for such imaging, an undulator on a 1 to 2 GeV next-generation storage ring, will have coherence properties similar to those believed achievable with VUV and soft x-ray harmonics of visible and UV lasers. In fact, at shorter wavelengths, the undulator should provide higher average power than laser based sources (reference 27).

The foregoing selective examples show that synchrotron radiation is used for many purposes by scientists from a variety of disciplines. Research groups are combining the use of synchrotron radiation with other techniques, such as molecular beam epitaxy, pulsed lasers, and electron energy loss spectroscopy.

The versatility and power of research based on the characteristics of synchrotron radiation have emerged in the past 15 years. With the new capability provided by insertion devices, primarily undulators, the future impact of these devices will be even more profound.

NEUTRON SCATTERING RESEARCH: PAST AND FUTURE

Worldwide neutron scattering facilities and research applications have grown dramatically during the past decade. The most notable example is the emergence of the British/French/German center at the Institut Laue Langevin at Grenoble. But the Grenoble facility is only part of a major transformation of the field throughout Western Europe and more recently in the United States and Japan.

A New Generation Of Instruments: Europe And The United States

Over the past 25 years, the unique characteristics of the neutron as a probe of condensed matter has transformed much of our fundamental understanding of the physics and chemistry of materials. In keeping with this, a new generation of cold and thermal neutron instruments has been developed during the last decade, particularly in Europe. These have extended the wavevector range and energy resolution for neutron experiments by orders of magnitude. And they have, in turn, made possible new research in physics and chemistry and greatly expanded the applications of neutron scattering to new areas--materials science, polymers, and biology. Thus, the neutron scattering community in Europe has tripled in the past decade, and, more recently, the neutron scattering community in the United States has nearly doubled. This growth has also been stimulated by the emergence of higher-intensity pulsed neutron sources which by providing higher neutron energies have created new opportunities for neutron scattering research (reference 7).

The emphasis at current steady state reactor centers in the United States has been primarily on forefront research rather than on the development of instrumentation. This has been dictated, in part, by the U.S. neutron funding profile. By necessity, and in contrast, the pulsed source programs at Argonne and Los Alamos have emphasized development of pulsed source instrumentation and techniques, although important research has also been accomplished there.

Early neutron scattering research focused primarily on the exploration of basic issues in condensed-matter science. These issues included phonon and magnon dispersion relations, the structure of hydrogenous materials, crystallographic and magnetic structures in simple solids, and phase transitions in model systems. In the past decade, the range of systems under examination has broadened considerably, and the scientific issues have often become much subtler. Neutron scattering has thus become an essential tool, providing unique structural and dynamical information central to the elucidation of the physics, chemistry, and other attributes of systems that are typically of interest to very broad communities. This change in character is evident in the outstanding accomplishments involving the use of neutrons in the last decade at major centers around the world.

These accomplishments include elucidation of (a) the structures and transitions in magnetic superconductors, (b) the physics of disordered magnets including metallic glasses, percolating alloys, spin glasses, and random field magnets, (c) the structures and excitations of incommensurate systems, especially those involving one-dimensional mass and charge density waves, (d) tunneling modes in chemical systems, including deuterated solid methane and hydrogen trapped by impurities in metals, (e) stoichiometric rearrangement and diffusion mechanisms in fast ion conductors, (f) early stage nucleation of voids in metals, (g) single polymer chain configurations in bulk polymers as well as composite polymer materials, (h) the spatial organization of macromolecular assemblies such as ribosomes, and (i) the location and exchange of hydrogen in proteins.

Finally, there have been important contributions to basic particle physics, including the determination of an upper limit on the electric dipole moment of the neutron, an upper limit on the occurrence of nonlinear terms in the Schrödinger equation and limitations on the incorporation of gravity in the Schrödinger equation. In all of these cases, neutrons have played an essential role.

In spite of major contributions to these and other impressive accomplishments, the current state of the U.S. neutron facilities is unsatisfactory. The broadening of the scientific base of neutron scattering necessitates the development of new capabilities at existing facilities with a new generation of instrumentation. Further, by the mid-1990's our existing reactor sources will be 25 to 30 years old, so that their long-term viability becomes a serious issue. In addition, many experiments of current interest turn out to be signal- or resolution-limited, so that greatly increased fluxes are required. This can be achieved by developing a new steady state reactor and a new pulsed spallation source.

Against the above summary of past accomplishments, the Committee describes areas of materials research and other fields in which neutrons can be expected to make important future contributions if advanced instrumentation and new facilities are developed in the United States.

Condensed-Matter Physics

A major fraction of neutron scattering research traditionally has been directed toward condensed-matter physics. Concomitantly, there is a continuous stream of interesting and important physics problems for which neutrons provide essential information. There are, however, a quite large number of problems in condensed-matter physics of immediate importance that cannot currently be addressed in the United States because of limitations on instrumentation or flux. This class of problems is discussed below with emphasis on four research areas.

First, as a result of rapid progress in the techniques of mateials fabrication, a remarkable variety of lamellar materials can be synthesized. In all of these, there are important structural and lattice dynamical questions that often can be addressed only with the use of neutron scattering. Examples include artificial multilayer materials such as $GaAs/GaAl_xAs_{1-x}$, and CuNi. High-resolution studies of superlattice effects in the phonon dispersion relations are surely needed. Other important low-dimensional systems include graphite intercalation compounds of which very high quality but rather small (about 0.5 mm^3) single crystals have recently been produced, and also hexatic smectic liquid crystals. Studies of in-plane dynamics of the intercalates and of excitations in hexatic phases would yield fundamentally new results. A related and rapidly-growing area of research centers about the determination of the structure and dynamics of adsorbed species of molecules, especially hydrocarbons on high surface area substrates. All such studies would require high resolution and a copious flux of cold neutrons.

Second, in studying highly disordered magnets involving competing interactions, such as spin glasses and random field magnets, it has been found that important new effects occur in the time domain; for example, the system gradually freezes into a metastable state with decreasing temperature. Moreover, pronounced hysteresis effects that depend on the prior history of the sample are observed. This class of problems, which promises to grow in importance over the next decade, requires use of the very high energy resolution provided by the spin-echo technique.

A third new area of materials research relates to the study of nonequilibrium phenomena such as spinodal decomposition in supersatured alloys and turbulent flow in anisotropic liquids. The advent of wide angle position-sensitive detectors and modern data acquisition systems provides important new opportunities for such studies. Using a next-generation reactor source, one may expect to collect complete powder diffraction or small-angle scattering patterns with reasonable statistical accuracy for periods of time between 0.01 and 0.1 sec. This will allow probing the early time behavior of such systems.

A fourth area of research that has always been severely limited by both flux and instrumentation is the scattering of polarized neutrons. Polarized neutron techniques allow separating magnetic and nuclear scattering as well as coherent scattering and incoherent scattering arising from nuclear spins. An order of magnitude increase in flux, with improved polarizers for neutrons of short wavelength, would make many new experiments possible. Examples include studies of the excitations in magnets above the thermal transition temperature, elucidation of the spin dynamics in rare earth materials with mixed valences, separation of the magnetic scattering in spin glasses, and studies of magnetic defects in antiferromagnets.

There are, of course, always many important materials where, in spite of the best efforts of crystal growers, small sample size limits or prevents the full range of useful neutron experiments. Examples include Nb_3Sn, Nb_3Sb, $MEM(TCNQ)_2$, $ErRh_4B_4$, as well as others mentioned above. An order of magnitude increase in flux would bring many such problems into reach.

Finally, the increased neutron flux in the epithermal range will enable access to important new information on high-energy magnetic excitations in transition metals, actinide compounds, rare earth metals, and intermetallic compounds. Experiments involving the determination of the single particle momentum distribution in He^4 and He^3 as well as other light atom systems can also be anticipated.

Materials Science

Polymer and Colloid Science. The availability of small-angle neutron scattering (SANS) facilities has led to revolutionary advances in polymer science over the past decade. As indicated earlier, the substitution of deuterium for hydrogen makes it possible to extract information concerning the global molecular geometry of polymer molecules in the presence of high concentrations of other polymer molecules having the same chemical structure but differing isotopic compositions. There are at present no other experimental methods for making such measurements. Results have stimulated significant advances in understanding that, in turn, have led to new experiments. These SANS experiments have been carried out primarily on an instrumented cold neutron guide at Grenoble, although useful work has been achieved at new U.S. facilities. Important accomplishments include measurements of the conformation of single molecules in dilute and concentrated solutions and in amorphous bulk polymers. The state of miscibility of polymer blends and the state of aggregation of polymeric superstructures can also be characterized.

Extensive exploration of molecular interactions and phase diagrams over a range of temperature, concentration, and pressure will be required in the future. Those experiments will be dependent on greatly increased fluxes to achieve realistic data collection times. There is also a compelling need for studies of the dynamics of polymeric systems in real time--including phase transformation rates, deformation rates, annealing, and conformational changes. Measurements at lower wave vectors (q) are also needed to enable one to look at progressively larger polymeric molecules. Such new applications require modern SANS instruments located on cold source guide tubes with copious fluxes.

So far, only a limited number of low-energy inelastic scattering experiments have been reported in polymers. Here one is especially interested in low frequency motion in which long sections of the polymer molecule move in concert. Real advances require the development of spin-echo spectrometers, which also incorporate high-q resolution, along with back-reflection spectrometry having high-energy resolution. Quasi-elastic neutron scattering instruments covering an extended q range, from 0.01 to 2 Angstroms^{-1}, could, for example, provide an integrated understanding of the high-frequency motions that determine the chemical and electrical properties of polymers, and the low-frequency motions that dominate their mechanical and transport properties.

Metals, Alloys, Ceramics. The start-up of the high-flux, SANS instrument at Grenoble in the 1970's, along with earlier ground-breaking work at Jülich and Saclay, marked a turning point in the use of neutrons for studying structural and related problems in metals and alloys. These instruments made it possible to examine heterogeneities in bulk samples at small wave-vectors without multiple scattering. Important failure mechanisms in these materials are associated with the formation of small voids, often located at grain boundaries. These include radiation damage, hydrogen charging effects, high temperature fatigue, and creep. In the past, the small size of these pores and their low fractional volume made it difficult, if not impossible to obtain statistical information or to follow the growth and linkage leading to failure. Such studies are vital to test competing theories in these areas.

Another important use of SANS has occurred in the study of clustering and precipitation phenomena in alloys as well as in the investigation of internal oxidation. Here, again, important tests of theory, such as scaling laws, are occurring. Activities by U.S. scientists in this growing field which uses SANS facilities recently developed in this country, as well as the Grenoble instrument in Europe when available, to obtain additional sensitivity or resolution, are already making major contributions.

In spite of the progress that has already been made, the application of SANS to the study of microstructure and distributed damage in real engineering materials is at an early stage. There is a need to investigate the formation of voids and precipitates in steel and other structural alloys from a very early stage of development, emphasizing size and volume fraction. The exploitation of this and other major opportunities in the next decade will require the development in the United States of much higher intensities of neutrons of long wavelength, along with more efficient and effective collimation and area detection systems.

The attainment of much higher intensity SANS instruments will also permit the kinetics of processes such as precipitation, phase decomposition, and grain coarsening to be followed in real time, on a scale of about 0.1 sec or greater, under realistic conditions of temperature and stress. Higher sensitivity and resolution, as well as longer neutron wavelengths, will be needed to test models of damage accumulation that lead to failure of materials and of structures. Such capabilities will also be important for new areas, making possible, for example, in-situ studies of densification of ceramics at various stages of processing.

Other recent advances include the rapid development of high-resolution powder diffraction equipment at pulsed neutron and reactor sources. This not only permits the determination of the structure of materials such as complex ceramics and catalysts, which cannot be obtained in single crystal form, but also makes possible the study of residual and interaction stresses as a function of depth in metals and multiphase materials. Energy-dispersive pulsed source techniques have proven to be particularly useful in many of these studies. It is clear that such investigations will increase in importance in the next decade, particularly as much higher neutron intensities become available, allowing the stresses in smaller-volume elements in structural materials, and more complex structures, to be probed.

Chemistry

The most exciting opportunities for applying neutron scattering to condensed-matter chemistry in the next decade will require the development of instrumentation with very high resolution and high sensitivity for both elastic and inelastic scattering. In dynamic studies, this is particularly true for low energy cold neutron spectroscopy (0 to 20 meV) and quasi-elastic scattering, in which the use of neutrons provides unique information relative to other approaches. There is a growing interest in fundamental studies of rotational processes and interactions, tunneling phenomena, and ionic and molecular diffusion mechanisms in solids, as well as of molecular species bound in homogeneous and heterogeneous chemical media. The study of the dynamics of such systems on an atomic and molecular scale is of great importance, for example, in gaining understanding of the behavior and activity of catalysts and chemical absorbents, as well as of intercalated and layered materials. The studies will require energy resolutions between 0.1 μV and 0.1 meV, depending on the dynamic modes or processes being investigated.

Future applications of high-energy neutrons to determine vibrational spectra using pulsed or reactor sources will require considerably higher resolution as well as spectral measurements for variable wave-vector transfers. Experiments carried out under these conditions require much higher neutron fluxes to allow accurate measurements of line shapes and spectral intensities. This will, in turn, be necessary to test dynamic models of molecules bound in chemical systems. Moreover, many of the future applications of neutron scattering in chemistry will involve the measurement of high-resolution difference spectra, in which the signal from the species of interest is small in comparison with that from the surrounding medium. This small signal, coupled with the often small sample sizes, will accentuate the need for higher neutron intensities and new instruments. Measurement of difference spectra will make it possible, for example, to study the bonding, diffusion, and interaction of molecular species adsorbed in supported catalysts, as a function of the size of the catalyzing metal particles. Systematic studies using different catalysts, supporting substrates, and impurities are also of great interest.

In chemical crystallography, one of the requirements for neutron research in the next decade will be the extension of powder diffraction studies to ever higher resolution, so that more complex structures can be determined under wide ranges of temperature and pressure, for example, in ionic conductors, ceramics, catalysts, and even organic solids. High-resolution instruments will also be required to evaluate the details of disorder in complex stoichiometric and nonstoichiometric materials. For example, such new instruments will aid in the determination of the effect of incommensurate arrangements of oxygen and metal atoms in ceramics on the chemistry of these materials, such as titanates and niobates. In addition, studies of small single crystals, less than about mm^3, of many new materials, including ceramics and inorganic complexes, will be required. Finally, there is a growing interest in real time, in-situ studies of atomic rearrangements occurring during solid state chemical reactions. All of these emerging applications require higher-intensity beams and greatly extended use of high-efficiency detectors and multidetector analyzers.

In the area of molecular liquids, the investigation of the relationships in dynamical behaviors of complex solutions, colloids, and micellar systems by small-angle neutron scattering and inelastic scattering will require high-resolution instruments currently unavailable in the United States, including considerably more intense sources of cold neutrons. This research is essential for understanding how the properties of such systems are affected by the concentration, complexing agents, and constituents of the surrounding medium.

Biology and Medicine

Studies of the structure and dynamics of biological molecules and molecular assemblies will continue to be of major interest during the next decade. The use of neutrons and photons has provided much of the major understanding that we presently have of the molecular structure of biological substances, and continued development of these uniquely useful probes is essential.

The principal growth in the use of neutrons will be in the wavelength range from 3 to 20 Angstroms. Shorter wavelengths are appropriate for the study of macromolecular crystals at the atomic level. Good facilities for such measurements presently exist at the Brookhaven National Laboratory and at the National Bureau of Standards, although additional facilities and higher intensities would be welcome.

There is a major need for further instrumentation and development in the area associated with cold neutron research. This domain will include structural studies of macromolecular assemblies at low resolution, possibly through the use of crystals but certainly with solutions. Selective deuteration methods will be extensively used. Such approaches have been used successfully in studies of the structure of lipoproteins, ribosomes, nucleosomes, and DNA-dependent RNA polymerase from *E. coli*. The analyses of many other macromolecular assemblies that may be amenable to neutron analysis now lie on the horizon, including studies of the RNA-protein complexes involved in processing messenger RNA and in controlling secretion. The higher-order structure of chromosomes is also of great interest and could be studied with neutrons of long wavelength.

Similarly, the study of biological membrane structure and the interactions of membrane components has provided a fertile area. Methodological refinements will permit a wider range of experimentation to probe both macromolecular interactions and membrane structures. Problems concerning the solvation of macromolecules, the formation of complexes between enzymes and substrates, and the interaction of ions with macromolecular surfaces are being pursued using scattering from solutions. Finally, recent applications of inelastic neutron scattering to macromolecules in solution suggest the possibility of obtaining fundamental thermodynamic parameters associated with macromolecular properties, and observing alterations in dynamic states that are correlated with functional changes in biological molecules. While this is a new area, success could lead to a greatly expanded use for inelastic scattering spectrometers that measure energy changes in the range from 0.01 to 100 meV. Thus, the needs for the coming decade in the neutron area are principally focused on the development and exploitation of instruments for cold sources.

Earth Sciences

Greatly improved energy-dispersive diffraction capability is required in the field of earth sciences. Here high-resolution diffraction of minerals at very high pressures, simulating geological stress conditions, is extremely important. Higher intensity pulsed sources will prove useful by permitting smaller samples and higher pressures to be employed. As in chemical crystallography, an order of magnitude increase in the flux from a steady state source would make it possible to greatly reduce required crystal sample volumes and open up a much larger number of mineral samples to investigation.

RESEARCH WITH MAGNET FACILITIES: PAST AND FUTURE

High magnetic field research is important for a fundamental understanding of a broad spectrum of material types and properties. Scientific advances in such diverse areas as superconductivity, permanent magnet research, and semiconductor science have all benefited from research based on the availability of intense magnetic fields. The attainment of such fields has, in general, been preceded by, and intimately connected with, applications developments and industrial commercialization. Each time a higher plateau of magnetic field strength is achieved, it is exploited quickly by the scientific community and is accompanied by the requirement for yet higher field strengths. The combination of high fields and low temperatures is particularly important, along with ancillary measuring equipment such as that associated with precision optical measurements.

The Francis Bitter National Magnet Laboratory is the primary high magnetic field research facility in the United States. Direct current (dc) fields in the 20 tesla (T) range are available using Bitter magnets. To reach higher fields, hybrid magnets utilizing both superconducting and resistive coils are required. Using such procedures, the National Magnet Laboratory has achieved a steady state field of 30.4T. The ultimate limit for dc hybrid magnets appears to be 35 to 45T, beyond which pulsed magnetic field systems are needed. The National Magnet Laboratory currently offers nondestructive pulse systems to 45T. Higher pulse fields, perhaps up to 100T, appear to be achievable using advanced technology. In addition, the National Magnet Laboratory provides limited high-field, low-temperature facilities as well as high field facilities coupled with a variety of ancillary measurement equipment.

A great deal of progress in a number of areas has been made using relatively low fields, of the order of 1 to 2T, but the number and types of useful experiments that can be performed increase dramatically with higher field strengths. For example, the Zeeman splitting of a single electron in a field of 1T is the energy equivalent of only 1.4K. Increasing the field to 100T raises the splitting to 140K, which is comparable to typical exchange and crystal field energies in many magnetic systems. This raises the possibility of inducing large changes in the electronic structures and behavior of both magnetic and nonmagnetic systems simply by applying of such large fields. Some recent examples of exciting high magnetic field experiments are studies of the fractional quantized Hall effect at semiconductor interfaces, measurements of important superconductivity parameters such as H_c in materials that have significant technological applications, and the newly observed magnetic field induced charge-density-wave transition in graphite.

Clearly, the ready availability of higher magnetic fields could enhance measurements currently being made and create new research opportunities. A study by the NRC Solid State Sciences Committee conducted in 1979 but still valid today concluded (reference 3) that the availability of higher magnetic fields would open up many new, exciting, and profitable areas of research. The study found that one of the areas profoundly affected is that of semiconductor research. As a recent example, clear data elucidating the quantized sub-integer Hall effect have been obtained in experiments up to 28T and at ultra-low temperatures (50-100 milli K). Although not totally understood, these results are thought to arise from collective effects which suggest the possibility of additional phenomena to be investigated at even higher magnetic fields and with improved ancillary conditions. Among such physical phenomena might be unusual effects associated with charge density waves and, in the low density limit, Wigner crystallization. The latter possibility is particularly interesting for a high mobility two-dimensional electron gas that can be achieved in a selectively doped semiconductor heterostructure. Such an experiment would require the 2d electron gas to be in the high field limit in order to reduce kinetic energy effects. Generally, such studies could have a major impact on improving our understanding of electron-electron correlation in an electron gas. Further, many of the techniques used to explore the electronic structure of semiconductors require that the cyclotron resonance frequency be high in comparison to the inverse scattering time of the electrons. For many materials, the scattering times are so short that this condition cannot be fulfilled with currently available magnetic fields. The only alternative in such cases is to go to higher magnetic fields. Other interesting phenomena in semiconductors that could be examined if sufficiently high magnetic fields were available include the breakdown in the effective mass approximation, electron-phonon "enhancement effects," and Zeeman splitting of deep impurity states.

Similarly, new scientific opportunities in metals and alloys emerge if intense magnetic fields are available. Many important metals and alloys have Fermi surfaces or parts of Fermi surfaces that cannot be measured at present, because either the effective mass or the electron scattering is too large. Both limitations could be surmounted in strong magnetic fields. Not only would it be possible to study the Fermi surfaces of exotic materials, but also of alloys well beyond the dilute limit. One might also envision measuring the Fermi surface of an alloy as it changed from the ordered into the disordered state. The age old problem of driving an exchange-enhanced paramagnetic system into the ferromagnetic state by applying a sufficiently large magnetic field might now be possible. Ferromagnetic Pd has not been found to date with the fields presently available. Increasing the upper limit for available magnetic fields might result in the induction of ferromagnetism in Pd.

The past several years have seen very exciting developments in the field of high-performance permanent magnet materials, especially new alloys based on the rare earth/iron/boron ternary compound, $Fe_{14}Re_2B$. The characteristics of these new materials for permanent magnets are based on large magnetization, very high magnetic anisotropy, and favorable microstructure. In a number of cases, such materials require magnetic fields in excess of 10T to achieve states near saturation. As improved materials become available, the field-intensity requirements may be even greater. The achievement of saturation fields is necessary not only in the production of permanent magnets, but in determining their fundamental properties from single crystal and oriented powder measurements. This provides a clear example of a field of research in which the availability of high magnetic fields could have a significant impact on major technological developments.

As discussed in the overview of this chapter, the study of superconductivity is the area of research that is most strongly linked to the production of high magnetic fields. Among materials currently being studied because of their interesting potential for use in high magnetic fields are the Chevrel phases, the B1 and A15 structures, as well as various types of thin film and inhomogeneous superconductors. High magnetic fields are also essential for probing those fundamental properties of superconductors that can be used to test microscopic theories, such as those associated with certain types of electron pairing--singlet, triplet, etc.—as well as other basic features of high field superconductivity.

In addition to research areas involving high magnetic fields in a very fundamental way, there is a vast array of fields involving spectroscopic and other techniques that use high magnetic fields as a probe for extracting important information about the properties of physical, chemical, and biological systems. For many of these, such as nuclear magnetic resonance (NMR), electron paramagnetic resonance (EPR), and the de Haas-van Alphen effect, the increased energy splitting available with higher magnetic fields provides tremendously enhanced ability to obtain information. At fields approaching 100T, energy splittings can also be great enough to have a direct effect on such phenomena as metallurgical phase transitions and chemical reaction rates. The ready availability of magnetic fields in these higher ranges would undoubtedly lead to a wide variety of applications and processes which utilize them in new and novel ways.

ADVANCED TECHNOLOGY NEEDS: APPLICATIONS OF NEW FACILITIES

The technological breadth of materials research can be sampled by looking at both the list of available applications in Table II.2 and the list of materials of economic importance in Table II.1. Technologically important examples have been described earlier in this chapter and are also given in numerous reports (references 1, 2, 3, 5, 6, 7, 8) dealing with synchrotron radiation, neutron scattering, and magnetic fields. Given below are examples of the connections between subareas of materials research and other fields which use major facilities and are linked to technological applications of national interest.

Semiconductors underlie all components involved in information systems--communication, computers, electronics. Techniques available at synchrotron radiation and neutron facilities are used to study structural and dynamic properties of semiconductors, including their interfaces, surfaces, and defects. X-ray scattering studies probe the atomic structure of semiconductors, while photoelectron spectroscopy techniques probe their electronic structure. Impurities of electrical importance in the range down to about 0.1 ppm or less, could be studied nondestructively using an x-ray microprobe on a new 6 GeV storage ring. High sensitivity, three-dimensional depth profiling of impurities and dopants in semiconductors and insulating films, can be studied with neutrons at concentrations down to 1 ppb if high-intensity cold neutron beams become available. X-ray lithography offers significant promise for fabricating precise submicron semiconductor structures for future VLSI applications. Doping by neutron transmutation is an essential tool for the production of semiconductor elements.

Essentially all other electronic materials, including metals, insulators, polymers, ceramics, and magnetic materials, can be characterized in unique ways using synchrotron radiation and neutrons. New structural and electronic properties of bulk and thin film materials, as well as interfaces, defects, and surfaces can be studied in novel ways.

The use of special techniques is crucial if we are to obtain an understanding of the interfaces which lie at the heart of the devices used in modern electronics. In addition to providing knowledge concerning semiconductor interfaces, synchrotron-radiation-based surface science and neutron depth profiling are also useful in exploring interfaces at junctions of metals and insulators with semiconductors, both of which represent important physical features of modern electronic devices. In the future, more intense sources offer the ability to study the time dependence of surface and interface reactions, as well as opening up the possibility of developing microfocused beam techniques.

Extended x-ray absorption fine structure (EXAFS) has been widely used by industrial researchers to study materials. Examples involve the local atomic arrangements in alloys, specific impurity sites in coal, and active sites of catalysts. EXAFS spectra have been taken of a catalyst operating in a fuel cell. Future examples include the study of new materials produced by ion implantation, studies of the role of minority elements in alloys, and studies of composites.

Increased brightness from new sources will make it possible to use smaller concentrations and to follow changes on a more rapid time scale. Parallel studies with an x-ray microprobe will offer spatial resolution as well, so that grain boundaries can be studied. Scattering studies of complex materials like oil and structural materials are providing a microscopic understanding of such materials for the first time. As was the case in the electronics industry, such understanding will contribute significantly to future innovations in the energy industries.

The availability of facilities for SANS and high-resolution neutron spectroscopy has led to revolutionary advances in the understanding of polymers and many other materials in the past decade. The availability of more intense neutron sources will greatly expand the technological uses of SANS. For example, capabilities for high-sensitivity SANS will be needed to study in-situ microstructures that determine the strength and performance of lightweight, high-strength alloys and superalloys for airframe members and engine components in military aircraft.

SANS studies of voids and very small precipitates produced in pressure vessel steels under irradiation in power reactors will provide valuable information. High-intensity, long-wavelength SANS and large-angle diffraction studies of bulk ceramics during various stages of densification as well as in-situ characterization of microcracks, pores, etc., which affect their durability, will be possible. Such knowledge may, for example, be of potential use when ceramics are employed in automobile engines. Cold neutron SANS and high-intensity neutron spectroscopy techniques will be needed for in-situ studies of the porosity, molecular behavior and interactions in new catalysts and feedstocks that are employed in the production of chemicals and fuels. SANS instruments using cold neutrons will allow the probing of biological assemblies consisting of enzymes, nucleic acids, and lipids, which control a large number of biochemical processes. These processes will often be relevant to biotechnological applications.

The unique characterization of materials with the use of high-intensity SANS will be available to study the polymeric constituents of new high-strength polymer blends and composites. This will include real time studies of phase separations related to processing. Such materials will provide increasingly important substitutes for heavier materials in autos, aircraft, and spacecraft.

Medical technologies are being advanced directly through the development of new diagnostic techniques. Moreover, the new light sources provide understanding at the microscopic level of many complex biological materials. A diagnostic example mentioned earlier is synchrotron radiation-based angiography. The study of platinum-based anti-cancer drugs by the EXAFS technique has provided clues to differences between effective and noneffective versions of these drugs. The production of medical isotopes using neutron sources will continue to be important in medical research, diagnoses, and therapy.

Synchrotron radiation and neutron facilities are important for the research programs of the defense agencies, both the Department of Energy and the Department of Defense. Advanced materials are of central importance to the defense agencies, which have needs ranging from information systems to structural materials involved in innumerable applications.

In a different class of application, remote sensors are employed in weapons tests, with particular emphasis on the hard and soft x-ray regions for diagnosis. Absolute absorption cross section spectra must be known, and detectors must be calibrated for such work. Both types of information can be obtained with the use of synchrotron radiation. While the temporal response of most detectors used in such work is faster than that of most synchrotron radiation sources, a next-generation storage ring will offer an improvement of about a factor of five.

There are several examples which illustrate the diverse applications of neutrons in research programs for national defense. High-intensity, energy-dispersive neutron diffraction is needed to measure local interaction stresses and textural characteristics which affect the performance of heavy metal shell components. Neutron depth profiling is needed to determine the tritium decay product (He^3) near the surface of refractory metals. High-intensity irradiation studies of metals and electronic components with fast neutrons are also essential.

In summary, the existing and proposed national facilities for materials research offer unique types of opportunities for both science and technology. It is difficult to think of significant issues affecting economic, defense, or health matters that cannot benefit in some essential way from the new opportunities presented by such facilities. This is, of course, the reason why they have already attracted the unparalleled participatory involvement of governmental and industrial research organizations. The new facilities considered in this report provide major opportunities for the next decade and beyond.

III. CONCLUSIONS AND RECOMMENDATIONS

The major facilities for producing synchrotron radiation, neutrons, and magnetic fields that are the focus of this report offer new opportunities essential for maintaining the progress and competitiveness of U.S. science and technology. These facilities will serve a broad spectrum of scientific fields, including materials research, biology, chemistry, atomic and molecular physics, plasma physics, the earth sciences, and medical science. As unique facilities offering incomparable scientific and technical opportunities, they will enable scientists and engineers to pursue otherwise inaccessible areas of science and technology. They will affect the technologies of information and defense, as well as those of energy, transportation, and health.

Materials research is the principal field served by these facilities. However, within this multidisciplinary field, there are also important research areas that are best served by specialized instruments of moderate cost that can be placed under the control of a single investigator or small group of investigators. Such research will often continue to be addressed most effectively by the Materials Research Laboratories and other relatively small and specialized research teams sharing comparatively small facilities, of the type described in Chapter I. Indeed, most of the research goals that the major facilities are expected to address originated through the insights of "small science" and will often be pursued jointly with groups also involved in small science.

The major materials facilities now operating--including those for neutron scattering, those for the production of synchrotron radiation, and the National Magnet Laboratory--are essential parts of the research effort of the United States. In some cases, these existing facilities will be superseded by new ones with additional capabilities. It will, however, be several years, and in some cases more than a decade, before the major new facilities recommended in this report can contribute directly to the national research effort.

The Committee emphasizes that its recommendations for major facilities--both new facilities and new capabilities at existing ones--embody two important prerequisites:

- That they are accompanied by expanded support of smaller materials research programs, including related instrumentation. Research on this scale continues to provide much of the fundamental new science in the field and to train a large fraction of our scientific and technical manpower.

- That resources must be provided to operate existing user facilities productively. In addition, the approved enhancements of major synchrotron radiation facilities at the Brookhaven National Laboratory, Stanford University, and the University of Wisconsin should be completed expeditiously, since it will require from several years to more than over a decade before the new facilities recommended in this report can contribute to the research effort of the United States.

RECOMMENDED PRIORITIES

The Committee's recommended priorities for the development and construction of facilities during the next decade include two categories:

- Major new facilities, and
- New capabilities at existing facilities.

These two categories complement one another in function, time and required resources. New capabilities at existing facilities are essential for scientific and technological needs during the next decade. The period from five years to more than a decade needed to construct major new synchrotron radiation and neutron facilities require that we start now in planning and designing these facilities. As discussed in Chapter II, failure to proceed with such new facilities will have an adverse and enduring impact on many fields of science and technology, diminishing the nation's competitive standing in such fields. The Committee concludes that both new facilities and new capabilities at existing facilities are essential for the effective evolution of science and advanced technology in the United States in the next decade and beyond.

The Committee also recommends the convening of additional panels to address other important aspects of materials research.

Major New Facilities

The Committee's recommendations for the construction of major new facilities are listed below in order of priority. A brief description and rationale is given for each recommended facility.

1. A 6 GeV Synchrotron Radiation Facility. This facility would effectively exploit the new scientific and technological opportunities made possible by insertion devices. These devices, by producing synchrotron radiation having orders of magnitude greater brightness than is currently available, would make it possible to expand on the seminal research using synchrotron radiation of the past decade. The first generation of storage rings designed as synchrotron radiation sources is now becoming operational, i.e., the National Synchrotron Light Source, at Brookhaven, and the Synchrotron Radiation Center, at the University of Wisconsin. While they will provide important capabilities, concurrent advances in design make it possible to construct storage rings and insertion devices with orders of magnitude improvement in brightness. A 6 GeV synchrotron radiation facility exploiting such advances offers both identifiable and as yet unforeseen opportunities for research not possible at present facilities.

This 6 GeV ring would have many long, straight sections containing insertion devices--undulators and wigglers. The storage ring would be designed to provide an electron beam that optimizes the emittance or intensity, or both, of synchrotron radiation from the insertion devices. A storage ring of about 6 GeV is optimal for producing undulator radiation in the 10 keV region where most x-ray research is done. The radiation from such a source would be orders of magnitude brighter than from any existing dedicated source. Wigglers on such a ring can provide unmatched intensity over a wide spectral region. The time-dependent characteristics of the radiation--short pulse length and long inter-pulse times--would make it at least as useful as that from existing sources. Moreover, insertion devices for the production of soft x-ray and vacuum ultraviolet radiation in the range from 100 eV to 1 keV would yield a thousand-fold brighter radiation than any source now operating, although not as bright as those possible on a new 1 to 2 GeV ring (Priority 3).

Timely construction of a 6 GeV synchrotron radiation facility would give the United States continued leadership in this important and dynamic field. Site-independent design should begin immediately, and the choice of site and construction should commence as soon as possible. If construction begins, for example, in FY 87, operation is possible by FY 92.

2. An Advanced Steady State Neutron Source Facility. The goal is to achieve about ten times the flux of existing machines with a minimum requirement of five times the flux. There are two principal reasons for the priority.

First, and most important, a new high-flux source can be designed to optimize beam geometry and flux distribution, so as to yield increased intensities for all experiments. An increase of about ten times the flux of existing machines is an aggressive but technologically feasible goal. Neutron scattering is inherently a signal-limited technique. The new facility would greatly increase the range of neutron experiments in materials research and other fields, as well as the precision with which relevant energies and momenta could be measured.

Such a neutron source would ensure the United States a leading position in this field, especially in the cold neutron range, where flux increases of an order of magnitude can be achieved. Such increases offer new capabilities, for example, in high resolution spectroscopy and studies of small angle scattering.

Second, the current high-flux reactors in the United States were all commissioned in the 1960's, so that there are significant concerns about their long-term viability. Given that design and construction of a new facility will require about a decade, planning must begin now to furnish needed capability for the late 1990's and beyond.

The Committee suggests that the design and construction of a new facility include the following: (a) at least one large guide hall containing many large-area guide tubes for cold and thermal neutrons; (b) a reactor hall containing many thermal beams, along with several "hot source" beams for high-energy neutron research; (c) a variety of spectrometers, including many with new capabilities beyond present designs; and (d) improved national facilities for isotope production, irradiation of materials, neutron activation analysis, and research in nuclear physics.

Instead of upgrading an existing reactor, a new facility should be built, and site-independent design should begin immediately. Because of the complexity of safety requirements, the Committee does not expect construction to begin until about FY 89, with completion possibly by FY 96.

3. A 1 to 2 GeV Synchrotron Radiation Facility. The Committee has concluded that, while the 6 GeV storage ring can furnish important new capabilities for the lower-energy region, a single such facility may not provide adequately for the national opportunities of the next decade. Among the reasons for this are: (a) the optimum storage ring energy for producing fundamental undulator radiation with wavelengths in the range of 10 Angstroms and greater is about 1.5 GeV, a region offering special opportunities for research in chemical physics and electron spectroscopy; (b) in addition to an increase in brightness, the unwanted total power density associated with a 1 to 2 GeV ring is significantly lower at wavelengths longer than 20 Angstroms; and (c) the undulator radiation from a 1 to 2 GeV source will have a higher degree of coherence than that from undulators elsewhere, thereby opening opportunities to apply various imaging techniques, such as microscopy and holography. A 1 to 2 GeV facility would provide optimal flexibility for both VUV and soft x-ray users.

This facility, then, would be centered around insertion devices but optimized for high brightness in the soft x-ray and VUV synchrotron radiation regions. The growth of research using these spectral regions has paralleled that in the x-ray region. Moreover, major advancements in design have occurred, permitting large increases in brightness for such a source.

4. A High-Intensity Pulsed Neutron Source Facility. Pulsed neutron facilities offer the best capability for sources of high-energy neutrons and the most promising approach to future advances beyond those that appear possible with steady state sources. In the few years that pulsed sources have been available, they have led to innovative research using new time-of-flight techniques and have served a broad user community, even though limited to modest peak fluxes.

The new capabilities recommended at existing facilities, for example, the attainment of a 10^{16} neutrons/cm^2-sec peak flux at the Los Alamos National Laboratory facility--Priority 3 in new capabilities given below--are expected to advance research using pulsed neutrons even further. Action on the design and construction of a pulsed source with a peak flux in the range of 10^{17} neutrons/cm^2-sec should be based upon the results obtained from such new capabilities.

New Capabilities at Existing Facilities

The Committee's recommendations for adding new capabilities at existing facilities are listed below in priority order. Brief rationales and descriptions are given for each recommendation.

1. Centers For Cold Neutron Research. Guide halls and instrumentation for exploiting the only cold neutron sources in the U.S., located at the Brookhaven National Laboratory and the National Bureau of Standards facilities, should be developed in an orderly fashion.

These facilities are urgently needed to address the rapid expansion of neutron applications in materials science, chemistry, and biology; many central problems in those fields can only be solved using new instruments with cold neutron beams. These centers will provide a diverse, flexible array of cold neutron instruments, matching current capabilities in other industrialized nations. Further, by using advanced techniques for beam focusing and polarization, such facilities would exceed existing worldwide capabilities, in areas such as high resolution spectroscopy of catalysts and polymer systems and in studies of impurities and inhomogeneities in bulk materials.

Research using cold neutron facilities has received inadequate support in U.S. during the last decade, a period of major investments in cold neutron research in other countries. The Western European investment alone is at least ten times that of the United States. There are only two cold neutron reactor sources in the United States one at Brookhaven and one being developed at the National Bureau of Standards. Guide halls, which improve the versatility and flexibility of cold or thermal neutron instruments, do not exist in the United States while there are six fully instrumented cold neutron guide halls either completed or under development in Western Europe. Implementing this priority will enable U.S. scientists to be competitive in cold neutron research during the next decade and will provide new instrumentation concepts for developing future neutron scattering facilities.

2. Insertion Devices on Existing Facilities for Synchrotron Radiation. Insertion devices and instruments should be developed in an orderly fashion to exploit about six of the remaining straight sections

of existing storage rings. The special characteristics of undulators as radiation sources should be emphasized, since they enable new capabilities not available presently at existing facilities.

Existing storage rings fitted with insertion devices will be our premier sources of synchrotron radiation for the next 5 years or more, or until new facilities described in this report are completed. Further, they will provide valuable experience for designing and implementing our next generation of synchrotron radiation facilities.

There are, currently, only four operational insertion devices, all wigglers. Nine new insertion devices have been proposed and approved for funding, of which only three are undulators. This number of insertion devices is clearly inadequate to meet future national needs and requires the development and implementation of additional devices.

Thus, the construction of additional insertion devices, when it is approved, should follow the construction of new capabilities at synchrotron radiation facilities already included in the budgets for FY 85 and FY 86.

3. Experimental Hall and Instrumentation at the Los Alamos National Laboratory. An experimental hall and new instruments at the Weapons Neutron Research/Proton Storage Ring (WNR/PSR) pulsed neutron source at the Los Alamos National Laboratory (LANL) would make the United States competitive in pulsed neutron research and would help guide the development of future pulsed sources. The expected flux increase at this facility provides an important opportunity to explore, at modest cost, the great promise of pulsed neutron science in relation to spectroscopic and structural problems. Although this technology is young, the instruments developed at the Argonne and Los Alamos national laboratories demonstrate that innovative approaches can produce enhanced capabilities.

Pulsed sources are superior to steady state sources in generating neutrons of short wavelength. It also appears that instruments for pulsed sources can be developed that will be advantageous at long wavelengths in certain cases. Developing the new source at the WNR/PSR at Los Alamos should, for a relatively modest investment, provide an important new tool for research and also permit a detailed assessment of the best course for developing future pulsed sources. Overall, the Committee feels that the WNR/PSR facility should be exploited fully. In considering the specific opportunity at Los Alamos, important factors taken into account were the peak intensity that could be attained (greater than 10^{16} neutrons/cm^2-sec), the relative economy of the investment, and the speed with which the facility could become operational.

4. Upgrade of the National Magnet Laboratory. The National Magnet Laboratory (NML) is the only high magnetic field user facility in the United States. Many areas of materials research require combinations of high fields and/or low temperatures. Both the 45T pulsed field system and the 19T/50 mK system at the NML require enhanced instrumentation to permit full exploitation. The position of NML as the leader in magnetic field research depends on the timely development of a new hybrid system that will provide higher fields at lower cost for a rapidly growing community of users. Additional funds are needed to

complete the project. A pulsed magnetic field system capable of 75T could also be placed on line more quickly with adequate funding. Recent experience shows that even modest increases in magnetic field capability can open new approaches for addressing important problems in condensed-matter science and increase the demand for NML facilities significantly.

5. Enriched Pulsed Neutron Source Target. Enriched targets exploit higher levels of fission to amplify the production of neutrons and can more than double the available flux. Such increases in flux are important because neutron scattering is inherently a signal-limited technique. The development and installation of enriched targets for use at pulsed neutron facilities would be cost effective.

Priorities 1 and 2 for major new facilities, when they are implemented, would serve as a centerpiece of this nation's future capability for synchrotron radiation and neutron based research. Thus, design and siting studies for a 6 GeV synchrotron radiation facility and for an advanced steady state neutron facility should begin immediately.

Because of the long lead time associated with an advanced steady state neutron facility, the immediate implementation of at least one instrumented cold neutron guide hall is necessary to provide forefront capability.

ESTIMATED COSTS OF THE RECOMMENDATIONS

To summarize the overall scale of its recommendations, the Committee presents, in Table III.1, its estimates of the requirements for new funding in millions of FY 85 dollars. The estimates in Table III.1 include costs of construction and initial instrumentation for major new facilities and new capabilities at existing facilities. Estimates for major new facilities assume initial instrumentation for one-half of the available beam line capability.

There are also additional costs associated with the development, maintenance, and scientific use of these advanced facilities. The Committee estimates related personnel costs to be about $250 thousand per year for each neutron or synchrotron end station. The same is true for major new magnetic field stations. A somewhat smaller amount is required for other experimental purposes and/or instrument maintenance. More detailed information can be obtained from the presentations included in the supplemental volume to this report. In addition, there will obviously be some incremental travel, subsistence, and experimental costs for the hundreds of scientists and engineers who will use these new facilities, costs which may be covered only in part by reassignment of funds used for other scientific purposes.

Table III.1 REQUIREMENTS FOR NEW FUNDING*

MAJOR NEW FACILITIES (Millions of FY 85 Dollars)

In order of priority:

1.	6 GeV SR Facility	$ 160
2.	Steady State Neutron Source Facility	260
3.	1 to 2 GeV SR Facility	70
4.	High Intensity Pulsed Neutron Source Facility	330

NEW CAPABILITIES AT EXISTING FACILITIES (Millions of FY 85 Dollars)

In order of priority:

1.	Centers for Cold Neutron Research	$ 25-35 each
2.	Insertion Devices on Existing SR Facilities	20
3.	Experimental Hall and Instrumentation at LANL	15
4.	National Magnet Laboratory Upgrade	5
5.	Enriched Pulsed Neutron Target	2-5

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* The Committee's estimates for construction and initial instrumentation costs are largely based on information from facility presentations, program officers, and other knowledgeable colleagues.

Major New Facilities

1. The new 6 GeV synchrotron radiation facility has an estimated cost of $160 million, including $125 million for construction and $35 million for instrumentation. The instrumentation would equip fully about 10 insertion devices, and associated beam lines, with about 20 experimental end stations. The estimated operating cost is about $20 to $25 million per year.

2. The new steady state neutron source has an estimated facility cost of $260 million, including $220 million for construction and $40 million for about 20 instruments. The estimated operating cost is $12 million per year.

3. The 1 to 2 GeV synchrotron radiation facility is estimated to cost $70 million, including $50 million for construction and $20 million for the instrumentation of 6 instrumented beam lines with about 12 end stations. The estimated operating cost is $9 million per year.

4. The high-intensity pulsed neutron source facility is estimated to cost $330 million, including $310 million for construction and $20 million for instrumentation of about 15 instruments. The estimated operating cost is $25 million per year.

New Capabilities at Existing Facilities

1. The centers for cold neutron research would cost $25 to 35 million each, about half for guide hall construction and half for instrumentation. The instrumentation funding would provide up to 20 cold neutron instruments and associated equipment. There are no incremental operating costs for the reactor associated with these new capabilities.

2. Insertion devices on existing synchrotron radiation sources would cost about $20 million for 6 fully developed lines, including about 12 x-ray and VUV instruments. There are no incremental operating costs for the associated synchrotron sources.

3. The experimental hall and instrumentation at the Los Alamos National Laboratory would cost $15 million and provide a large area for the installation of more than 10 instruments, 3 of which would be funded as part of the LANL proposal. Additional pulsed source operating costs of $2.7 million per year are required.

4. The National Magnet Laboratory upgrade requires about $5 million.

5. An enriched pulsed neutron target would cost between $2 and 5 million. Operating costs for the source would increase between $0 and 0.7 million.

Current major facilities will likely be superseded by the new facilities in certain cases, and their operating cost budgets will be transferred. An example is given by the steady state neutron source, whose construction could result in the phasing out of one of our current sources. This, in turn, would have the effect of requiring only a slight increase in net operating costs for the new facility.

The Committee considered possible funding schedules for each of the foregoing recommendations. In general, the new capabilities at existing facilities can be implemented within about 3 years from initial funding, whereas the major new facilities are estimated to require construction times from about 5 years to as long as 10 years.

In response to its charter, the Committee has determined the order of priority of construction of new facilities that are important for the rapid and effective progress of materials research and related fields. We show in Figure III.1 an estimated funding profile for design and construction associated with an expeditious implementation of all the items in these priority lists except for the 10^{17} neutrons/cm^2-sec pulsed neutron source facility, whose starting date is uncertain. The Committee does not necessarily recommend that all priorities be funded at the respective times indicated. The diagram is intended to suggest the approximate earliest possible start dates and construction time intervals for the various priorities. We note that accurate estimates of both construction costs and time schedules can only be obtained from specific proposals from specific institutions. The funding profile for priority 2 shown in Figure III.1b extends from fiscal years 1987 to 1989. Under this schedule, priority 2 modifications would follow the completion of those new capabilities at existing synchrotron facilities that are already included in the budgets for fiscal years 1985 and 1986.

With the foregoing in mind, several important general conclusions can be deduced from Figure III.1. First, implementation of new capabilities at existing facilities is complementary in time to the implementation of major new facilities. Second, with modifications of schedule, a relatively flat funding profile of construction is possible over the next decade, with an average expenditure rate of roughly $50 million per year for about a decade if all priorities are implemented. Third, the total construction fund of $588 million appearing in Figure III.1 is roughly comparable, in FY 85 dollars, to the average total U.S. capital investment per decade over the past two decades to provide facilities for synchrotron radiation, neutron production, and high magnetic fields, namely, in the range of $300 million, $500 million, and $20 million, respectively.*

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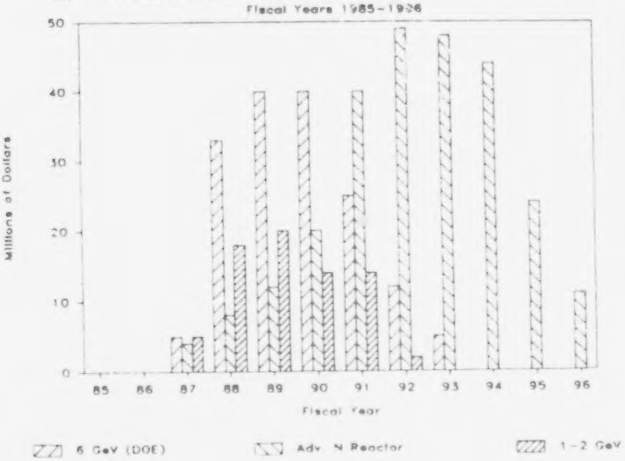
* The replacement costs in FY 85 dollars for existing multi-purpose neutron sources and related major instrumentation built over the past 20 years (primarily in the 1960's) is of the order of $500 million. This includes, for example, the HFIR at Oak Ridge, the HFBR at Brookhaven, the NBS reactor, the University of Missouri reactor, and the intense pulsed neutron source at Argonne. A comparable figure for synchrotron radiation sources and associated instrumentation (primarily developed over the past decade) is estimated at about $300 million including facilities at Brookhaven (NSLS), Stanford (SSRL), Wisconsin (Aladdin, Tantalus), Cornell (CHESS), and NBS (SURF II). Estimates for the synchrotron radiation facilities includes the construction cost of SPEAR at Stanford but does not include any share of other accelerator facilities used in a parasitic mode for synchrotron radiation at Cornell and Stanford.

A. ESTIMATED COSTS: NEW FACILITIES



B. ESTIMATED COSTS: NEW CAPABILITIES

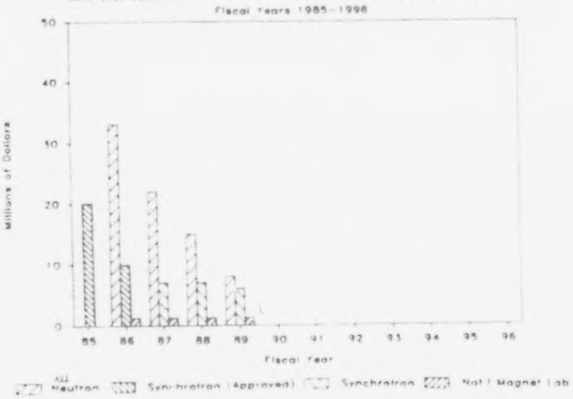


FIGURE III.1. Estimated Costs Versus Year. Estimated costs and earliest possible schedules for construction and initial instrumentation of (a) a 6 GeV synchrotron radiation facility, an advanced steady state neutron source, and a 1-2 GeV synchrotron radiation facility and (b) all recommended priorities for new capabilities at existing facilities.

The funding profile for priority 2 shown in Figure III.1b extends from fiscal years 1987 to 1989. In this schedule, modifications associated with priority 2 would follow the completion of those new capabilities at existing synchrotron facilities that are already included in the budgets for fiscal years 1985 and 1986. The Committee does not necessarily recommend that all priorities be funded at the respective times indicated.

OTHER SPECIALIZED FACILITIES CONSIDERED BY THE COMMITTEE

In addition to facilities for synchrotron radiation, neutron scattering, and high magnetic fields, the Committee surveyed other major facility needs and opportunities during the course of its study. However, none was identified that qualified for the priorities under the guidelines, namely $5 million minimum cost, established by the Committee's charter. We summarize here the specific items considered and the reasons for excluding them from detailed considerations.

Medium-Scale Specialized Facilities

The Committee briefly considered interdisciplinary materials research organizations, such as the Materials Research Laboratories (MRL) funded by the NSF and DOE, as well as special-purpose materials research laboratories or such centers for materials research as those on polymers, ceramics, and materials processing and other focused sub-areas of materials research. The Committee believes that such laboratories and centers represent a very important part of our overall national materials research program and that they fulfill national needs not otherwise satisfied by academic, governmental, or industrial laboratories.

The Committee heard excellent arguments for new facilities of this type, each of which can easily cost more than $5 to 10 million. However, the Committee excluded consideration of them without prejudice. It did so in part because of their "open-ended" nature. They require fuller definition through the formulation of specific proposals by specific institutions. The Committee did not request development of the details of such proposals when they were not already well formulated. Further considerations of important materials research laboratories and centers are deferred for future planning committees.

The Committee also discussed facilities for developing microelectronics processes. These are rapidly gaining national importance as microelectronic technology reaches submicron levels in silicon, and as materials other than silicon, such as gallium arsenide, are explored. Most large-scale facilities for microelectronics processing have, quite appropriately, been established by industry, though there is also a role for universities in this area.

Also discussed were facilities for high and ultra-low temperatures as well as those involving charged-particles such as electron microscopes and ion beam facilities, which can make major contributions to the analysis, synthesis, and modification of materials. The individual costs of these generally fall below the $5M threshold used by the Committee. As a result, and without passing any judgment on relative merits, such facilities would be better considered as part of the analysis of serious instrumentation needs mentioned earlier in this report. Such instrumentation will play important roles in conjunction with the use of synchrotron radiation sources, in which case their costs will be included along with those of beam lines.

Specialized Photon Sources

The Committee examined various other photon sources, such as high peak-power VUV excimer/dye-laser schemes, transition-radiation and bremstrahlung sources driven by intense relativistic electron beams, free-electron lasers, and soft x-ray sources derived from laser-heated plasmas. VUV laser sources based on nonlinear mixing of excimer and tuneable dye lasers were judged very promising. This technology deserves rapid development. The facility costs for such sources, although quite substantial when judged by traditional academic research standards, are expected to fall considerably below the Committee's $5 million threshold. Practical realization of the other photon sources listed above would require large capital investments.

However, only the free-electron laser appears to be of general interest at this time when employed in a user mode, because of its high brightness and broad tunability. This technology is currently under active development at many laboratories, both in the United States and abroad. The eventual utilization of free-electron lasers operating in the infrared seems a certainty. Efforts should be made to stimulate the establishment of a user community. The practical short-wavelength limit of such systems is not yet known, although operation of such lasers to 50 nm (5 nm with harmonic generation) has been projected. Considerable development effort is needed, particularly with regard to high-reflectance mirrors in this spectral region. Although it is premature to rank the value of free-electron lasers, they may eventually prove to be extremely important at photon energies in the range of 10 to 100 eV, and thus complement VUV/soft x-ray synchrotron radiation sources.

Computation Facilities

As indicated in Chapter I, the Committee also made an effort to examine the growing importance of large-scale computational support in the materials sciences. Theoretical materials science has now reached a point where, given adequate computer support, it can predict with quantitative accuracy, typically 1 to 10 percent, the physical properties of many materials systems, and thus complement experimental approaches.

The most effective kind of computer support for the national materials science community therefore is provided by a combination of a national network of Class 6 supercomputers and a number of smaller computers that are used by local or regional groups. The Committee strongly supports a major initiative in this direction now being undertaken by the National Science Foundation. It also strongly supports plans of the Department of Energy to extend the availability of networked supercomputers to scientists working in other areas. It hopes that other agencies supporting basic research will also take appropriate actions.

Muon Facilities

Pulsed muon beams, derived parasitically at high-energy particle accelerators, have received considerable attention for studies of condensed-matter physics that are based on measurements of spin-rotation. Several centers which support such research currently exist, and modest growth is anticipated. Some thought is being given to a major dedicated beam line at the Los Alamos LAMPF proton storage ring. The cost for such an addition may reach $30 million. It appears premature to judge the merit of such a facility, given the currently small size user community and the highly specialized nature of the technique.

Engineering Materials Test Facilities

Facilities in this category cover a very broad range with respect to the physical parameters studied and the associated capital costs. Major needs of this type for which federal, rather than industrial, funding is appropriate are primarily linked to mission oriented programs, such as national defense. As a result, they are not under the purview of the Committee.

Facilities Only Peripherally Related to Materials Science

Facilities whose principal purpose is not related directly to materials science were not considered by the Committee. An example is the proposal at Sandia for a Combustion Research Center (Phase II). The central thrust of this proposal is directed toward combustion science and technology. The behavior of materials at combustion temperatures is only one among a large number of other important topics projected for investigation at this laboratory as part of the new initiative.

APPENDIX A

National facilities for research in the physics of condensed matter

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Brief descriptions are given of 23 national facilities in the U. S. that are of importance to research in the physics of condensed matter. These facilities range from nuclear reactors and synchrotron sources to high-voltage electron microscopes and facilities for the preparation of special materials and submicron structures. They take a variety of forms and are located in several kinds of institutions, but are alike in being available to qualified scientists from other laboratories. The primary purpose, size, major experimental equipment, and method of operation are described for each facility.

PACS numbers: 29.25.Dz, 61.90. + d, 07.80. + x, 89.20. + a

INTRODUCTION

At the American Physical Society meeting in Los Angeles in March of 1983 an invited poster session was held on National Facilities of Importance to Condensed Matter Physics. The session was arranged by the Division of Condensed Matter Physics. There were 23 facilities featured, ranging from nuclear reactors and synchrotron sources to high-voltage electron microscopes and facilities for the preparation of unique materials or submicron structures. Most of the facilities on display have come into operation within the last five years, many within the last one or two. This fact reflects the rapid increase in the importance of large research devices and combinations of large devices in condensed matter physics, together with the necessity that, because of their cost such facilities be developed on a national basis and widely shared. Thus a pattern of usage is developing in condensed matter physics which has been common in particle physics for many years, and institutional arrangements are evolving for accomplishing this objective effectively and fairly. All these central facilities are governmentally funded. Only two, however, are operated directly by the federal government; the others are operated by contractors, many in national laboratories, some in state universities.

Even though the 23 facilities included all of the very large national facilities which are of prime importance to condensed matter physics, the display was not exhaustive. Other facilities exist that were not included because of space limitations. The list, however, gives an excellent view of the present national posture. It shows that the United States is in a strong position, but also makes it clear that condensed matter physics is a dynamic area in which rapid growth and frequent change must occur. It is hoped that this review will be valuable to potential users and will assist in the wide dissemination of information on what is available and how the interested researcher goes about gaining access to these centers.

It is evident that a strong trend toward national user facilities is still in full swing, and that more centralized facilities for condensed matter research will soon become available. Decisions on what new centers are most needed should be aided by this overview of what exists now.

In the following, a short synopsis of each facility is given, including its primary purpose, major equipment, size, and method of operation. Sources from which one can obtain more information are also provided.

The facilities are grouped under the following headings: (1) neutron sources; (2) synchrotron radiation sources; (3) facilities for microanalysis, microfabrication, and surface studies; (4) electron microscopes; and (5).

The writers are indebted to the operators of the various facilities for their cooperation in supplying information.

I. NEUTRON SOURCES

Nuclear reactors have been the traditional sources of neutron beams for condensed matter physics since the 1940's. Four U. S. reactors which are national facilities are described in this section. Also included is a facility within a facility, the National Center for Small Angle Scattering Research at Oak Ridge.

More recently pulsed neutron sources driven by medium energy accelerators have come on the scene, and two of these which are now national facilities are represented.

The main focus in what follows is on neutron scattering; radiation damage in materials has not been emphasized. Most of these facilities, however, also offer capabilities for exposing specimens to various kinds of radiation.

A. High Flux Beam Reactor, Brookhaven National Laboratory, Upton, NY

The High Flux Beam Reactor (HFBR) provides the scientific community with one of the most intense thermal neutron sources in existence today. The HFBR began operating in 1965 at a power of 40 MW. It has had a cold neutron facility with liquid-hydrogen moderator operating since April 1981. The reactor was recently upgraded and has been operating at 60 MW since September 1982. Many types of experiments are possible at the HFBR, including magnetic and nonmagnetic structure studies, phonon and magnon dispersion measurements, and diffuse scattering studies. Because of the relatively high energy resolution and the sensitivity of neutrons to magnetic moments and to the nuclei of almost all elements of the periodic table, neutron scattering makes feasible many studies which would be difficult or impossible with x rays. Facilities of interest to solid-state physicists at the HFBR include several triple-axis neutron spectrometers which can be used for both elastic and inelastic scattering measurements with incident neutron energies between 2 and 200 meV. A wide variety of different sample environments is available, including temperatures from 35 mK to 1500 K, magnetic fields up to 7 T, and pressures up to 35 kbar.

For additional information contact B. H. Grier or G. Shirane, Physics Department, Brookhaven National Laboratory, Upton, NY 11973.

B. High flux isotope reactor, Oak Ridge National Laboratory, Oak Ridge, TN

The High Flux Isotope Reactor serves the condensed matter physics community by providing high-intensity beams of thermal neutrons. The scattering facilities available include eight different instruments, not counting the 30-m Small-Angle Neutron Scattering (SANS) instrument described elsewhere. They are: (1) the triple-axis polarized-beam spectrometer, which permits polarization analysis experiments; (2) and (3) two general-purpose triple-axis spectrometers used for most of the phonon dispersion measurements, but which are also useful for modest resolution quasielastic studies and fairly high resolution powder diffraction studies; (4) a liquid diffractometer with a linear position-sensitive detector; (5) a double perfect-crystal, very-high-resolution SANS spectrometer which has been used primarily to study vortex lattices in superconductors; (6) a four-circle diffractometer for crystallographic studies; (7) a more limited triple-axis unit with a fixed incident energy of 14.7 meV; and (8) a time-of-flight correlation chopper spectrometer. The latter has been equipped recently with a system of ultrasonically pulsed silicon crystals to monochromatize and pulse the neutron beam incident on the sample.

A new two-dimensional detector has been developed; it utilizes a 12-in.-diam neutron-sensitive LiF–ZnS phosphor, an image intensifier, and a television camera system. This detector has been extremely useful in the observation of diffuse scattering, superlattice formation, and powder patterns, as well as crystal characterization, all in real time (less than a second). The system also has image storing capabilities.

Some of the auxiliary equipment includes furnaces, closed-cycle refrigerators, helium-four cryostats, a helium-three cryostat, a superconducting magnet, and a helium-three–helium-four dilution refrigerator with a split-coil superconducting magnet, which is capable of reaching 7 mK and a field of 5 T.

For additional information contact H. A. Mook, Solid State Division, Oak Ridge National Laboratory, Oak Ridge, TN 37830.

C. Research reactor facility (MURR), University of Missouri, Columbia, MO

The University of Missouri operates a 10-MW reactor as a neutron and gamma radiation source for condensed matter research. Interested parties from outside the University are encouraged to make use of the facility through cooperative experiments with members of the staff, or through the Reactor Sharing Program, supported by the Department of Energy. At MURR there are facilities to conduct experiments in at least four areas related to condensed matter physics research. (1) For neutron scattering, two triple-axis spectrometers are available to measure dispersion relations; two single-crystal diffractometers and one powder diffractometer are available to measure atomic and magnetic ordering in condensed matter systems; one small-angle neutron scattering spectrometer is available for polymer and molecular biological studies; a neutron interferometer can be used for special experiments. (2) For gamma scattering, three unique instruments are available: MUGS, which is a gamma-ray diffractometer for structure studies; QUEGS, which is a gamma diffractometer with Mossbauer energy analysis for quasielastic gamma measurements; and COGS, which is a Compton spectrometer now available for measuring momentum distribution of electrons. (3) Trace element analysis can be done by instrumental, radiochemical, and prompt neutron activation; it allows the characterization of elements in condensed matter samples. (3) Analyses of deep levels in the band gap of semiconductors can be made by using deep-level transient spectroscopy, current transient spectroscopy, and the newly developed charge transient spectroscopy, which allows 10^{10} deep levels per cubic centimeter to be detected.

For additional information contact R. M. Brugger, Director, Research Reactor Facility, Research Park, Columbia, MO 65211.

D. NBS research reactor, National Bureau of Standards, Gaithersburg, MD

The NBS research reactor is expected to double its power to 20 MW by the end of 1983. In March of 1983 it had 25 experimental facilities installed for materials reseach, activation analysis, radiation standards, and nuclear physics. Ten of the horizontal beam ports are dedicated to condensed matter science, with a wide variety of neutron scattering instruments installed. Special features include: (1) a three-axis spectrometer with two low background analyzer systems to allow measurements ranging from soft modes and spin-wave excitations in solids (as low as 1.0 meV) to the spectroscopy of low levels of hydrogen and molecular species in metals and catalysts (30–300 meV); (2) a multidetector high-resolution diffractometer used to study complex structures by powder diffraction, e.g., magnetic intermetallic compounds, catalysts, and ionic conductors; (3) a biological diffraction station used to study the structure of proteins; (4) a depth profiling facility for the nondestructive determination of density profiles of selected elements near surfaces; and (5) a small-angle neutron scattering facility with continuously variable wavelengths from 4 to 10 Å, a wave vector transfer range from 0.003 to 1.0 Å^{-1}, and on-line color graphics for the study of microstructure in metals, polymers, and biological materials.

For additional information contact J. J. Rush or J. M. Rowe, National Bureau of Standards, Washington, DC 20234.

E. National Center for Small-Angle Scattering Research, Oak Ridge National Laboratory, Oak Ridge, TN

The National Center for Small-Angle Scattering Research is a user-dedicated facility supported by the National Science Foundation and the Department of Energy under an interagency agreement. The two main instruments available to users are the NSF-supported 30-m small-angle neutron scattering facility (SANS) and the DOE-supported 10-m small-angle x-ray scattering camera (SAXS). These instruments are intended to provide state-of-the-art capability for investigating condensed matter structures in a range from a few tens up to several hundreds of angstroms. They are intended to serve the needs of scientists in the areas of biology, polymer science, chemistry, metallurgy and materials science, and solid-state physics.

For additional information contact W. C. Koehler, Director, or M. Gillespie, Secretary, NCSASR, Oak Ridge National Laboratory, Oak Ridge, TN 37830.

F. Intense Pulsed Neutron Source, Argonne National Laboratory, Argonne, IL

The Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory (ANL) is the most intense neutron spallation source now operating in the world. Protons from a 50-MeV linear accelerator and a 500-MeV rapid cycling synchrotron are delivered to a uranium target at a frequency of 30 Hz to produce neutrons. In the first year of operation 3370 h of research time were available. The peak thermal flux of IPNS is 3×10^{14} n/s cm^2.

The instrument package at IPNS has been designed with particular attention to the rich epithermal spectrum of neutrons present in such a spallation source. For example at 500-MeV IPNS has an effective flux approximately 10 times greater than the hot source at the Institute Laue Langevin (Grenoble, France).

The instruments for elastic or total scattering consist of two powder diffractometers (one a general purpose diffractometer and one a special environment diffractometer) which have excelled at high-resolution work and have also proven useful for studying amorphous systems. A single-crystal diffractometer is based on the Laue technique with a position-sensitive two-dimensional (30 × 30 cm) detector. A small-angle diffractometer also includes a position-sensitive detector, and is used for both metallurgical and biological problems. Of particular interest is the possibility of using epithermal neutrons in resonance small-angle scattering on biological molecules.

For inelastic scattering the crystal-analyzer spectrometer is particularly well suited to examine dispersionless high-energy vibrational modes. Two chopper spectrometers have proved exceptionally versatile in a variety of problems involving measurements of inelastic cross sections.

A new instrument, an electron-volt spectrometer, is under construction.

In the first year of operation approximately 120 experiments were performed at IPNS in the 3370 h of research time that was available. People from 23 universities, 5 industrial laboratories, 5 U. S. National Laboratories, and 8 foreign institutions were involved.

For additional information contact T. G. Worlton, Scientific Secretary, IPNS, Argonne National Laboratory, Argonne, IL 60349.

G. Weapons Neutron Research/Proton Storage Rings (WNR/PSR) Facility, Los Alamos, NM

The WNR is already operational as a high-intensity spallation neutron source. The user program was scheduled to begin in September 1983. Two-thirds of the neutron scattering beam time will be allocated for outside use and one-third reserved for in-house use. The first two user instruments will be the Be–BeO filter difference spectrometer (especially suited for chemical spectroscopy, and for studies of density of vibrational states and of optical modes of solids), and the single-crystal diffractometer (wavelength-resolved Laue camera). New instruments will be added to the user program as they become available and reach maturity. The tentative list of WNR instruments with their year of first operation and projected year for entry into the user program is: (1) filter-difference spectrometer (1980, 1983), (2) single-crystal diffractometer (1980, 1983); (3) liquids, amorphous, and special environment diffractometer (1980, 1984); (4) powder diffractometer (1980, 1984); (5) constant wave-vector-change spectrometer (1983,1985); (6) electron-volt spectrometer (1980,1985); (7) chopper spectrometer (1984,1986); and (8) small-angle diffractometer (1986,1987).

Some highlights of the research program to date include: (1) model-independent determination of the hydrogen–hydrogen pair correlation function in liquid water; (2) determination of the structure of the first molecular hydrogen complex; (3) observation of a new correlation of hydrogen bond vibrational frequencies with bond length for very short hydrogen bond; (4) development of the nuclear-resonance filter-difference method for electron-volt spectroscopy, and (5) observation of hydrogen momentum distributions in hydrides and water by scattering in the impulse approximation.

For additional information contact R. N. Silver, Group P-S, MS-H805, Los Alamos National Laboratory, P. C. Box 1663, Los Alamos, NM 87545.

II. SYNCHROTRON RADIATION SOURCES

The five synchrotron radiation sources in the United States are described here. The newest entrant in the field, the NSLS, is still in the process of coming into full-scale operation, and the others are still undergoing enlargement and improvement. This is a rapidly growing area of research throughout the industrialized world.

Figure 1 is an aerial view of the Stanford Synchrotron Radiation Laboratory.

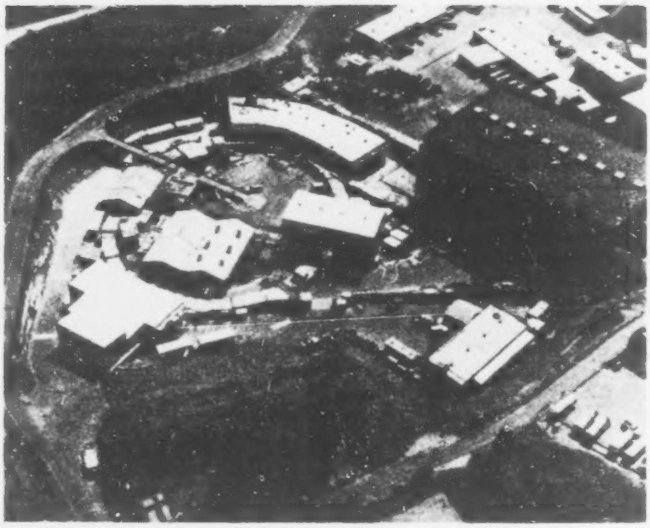

FIG. 1. An aerial view of the Stanford Synchrotron Radiation Laboratory.

A. Standford Synchrotron Research Laboratory (SSRL), Palo Alto, CA

SSRL is a national facility for the utilization of synchrotron radiation in biology, physics, materials science, medical science, and other disciplines. It is funded by the Department of Energy. The radiation comes from the storage ring, SPEAR, a facility within the Stanford Linear Accelerator (SLAC) built originally for high-energy physics research.

SPEAR is dedicated to the production of synchrotron radiation half of its operating time. During this time high currents of electrons, up to 100 mA are stored at high energies (3–3.5 GeV). The other half of the time the ring operates for high-energy physics research purposes to produce colliding beams of electrons and positrons. The ring is in operation between 8 and 9 months out of each year.

In addition to scientific research the Laboratory had a commitment to the development of advanced insertion devices for the enhancement of synchrotron radiation and the development of state-of-the-art instrumentation for the utilization of synchrotron radiation.

At present SSRL has 16 experimental stations on five beam lines covering the spectrum from 6 to 40 000 eV. A wide variety of experimental equipment is available for the user, and there are no charges either for the use of the beam or of the facility-owned support equipment. Both a 54-pole wiggler line and an undulator beam line serving three experimental stations are being developed; they will cover a range from 10 to 1000 eV.

SSRL is currently used by approximately 550 scientists from 124 different institutions, including universities, private corporations, and government laboratories.

As of March 1983 a total of 797 proposals had been received since March 1974, out of which 190 were active. A typical project involves four to eight scientists, including graduate students and post doctorals. Approximately 100 graduate students from 15 different universities work at SSRL each year. Over 200 publications based on research conducted at SSRL appear in journals each year.

For additional information contact A. Bienenstock, Director, Stanford Synchrotron Radiation Laboratory, P. O. Box 4349, Bin 69, Standford, CA 94305.

B. Cornell High Energy Synchrotron Source (CHESS), Cornell University, Ithaca, NY

CHESS, the Cornell High Energy Synchrotron Source, is a national laboratory which provides six x-ray experimental stations. X rays come from an 8-GeV electron storage ring (CESR). Monochromatic tunable photon beams from 4 to 100 keV are available. A six-pole 1.8-T wiggler provides a particularly intense spectrum with a critical energy in excess of 30 keV. The CHESS x-ray spectrum has a unique time structure—pulses come at 2.56 μs intervals with a pulse width of 0.13 ns.

Two stations provide white-beam capabilities, particularly useful for topography, high-pressure studies, and experiments that contain their own unique monochromators. A four-axis Huber diffractometer and two Picker diffractometers are available for diffraction physics experiments. Two complete EXAFS stations with data-acquisition software and off-line analysis packages are provided.

CHESS is supported by the National Science Foundation and currently provides experimental capabilities for approximately 100 active research proposals from all over the U. S. A.

For additional information contact Nancy Miller, Proposal Administrator at CHESS, Wilson Laboratory, Cornell University, Ithaca, NY 14853.

C. National Synchrotron Light Source, Brookhaven National Laboratory, Upton, NY

The National Synchrotron Light Source (NSLS) is designed to provide the world's brightest continuous sources of x rays and UV radiation. It is also the first x-ray facility in the United States dedicated for use as a synchrotron light source. It consists of two electron storage rings, one at 750 MeV for the production of vacuum ultraviolet (VUV) radiation, and one at 2.5 GeV for the production of x rays. In mid-1983 the VUV storage ring was in reliable operation with currents up to 300 mA and a lifetime of 2 h at 100 mA. The x-ray ring had stored beam, and initial operation for experimenters was expected during the latter part of 1983.

The VUV ring has 16 ports for VUV and IR research. It incorporates a unique free-electron laser designed to be a narrowband (relative bandwidth of 10^{-6}), continuously tunable (2000–4000 Å) UV source with average power in the range from one to several watts. The free-electron laser undulator can be used during routine storage ring operations to produce intense radiation between 100 and 2000 Å. The x-ray storage ring has 28 ports. Each of the 16 VUV and 28 x-ray ports is divided into two or three individual beam lines.

Under construction are several wiggler and undulator magnets which will significantly increase the photon energy and brightness.

The facility has a wide range of research equipment for basic and applied studies in condensed matter, surface science, photochemistry and photophysics, lithography, crystallography, small-angle scattering, metallurgy, x-ray microscopy, etc.

The NSLS is a national user facility, available without charge to university, industrial, national laboratory, and government users. There are several modes of use of the experimental facilities. A large number of beam lines have been designed and constructed by 27 participating research teams (PRTs). The PRTs are, for most part, user groups from outside Brookhaven National Laboratory with large, long-range programs which have been approved by the NSLS Program Advisory Committee. The PRTs are given priority for up to 75% of the operational time of their beam lines. General users will be scheduled for both PRT beam lines and for lines built by NSLS for the community in general.

For additional information contact M. Blume, Chairman, National Synchrotron Light Source, Brookhaven National Laboratory, Upton, NY 11973.

D. Synchrotron Radiation Center, University of Wisconsin, Stoughton, WI

The Synchrotron Radiation Center (SRC) of the University of Wisconsin operates the Tantalus 240-MeV electron storage ring and is bringing on line the Aladdin 1-GeV ring. When Aladdin is in operation, it will have 35 equivalent bending magnet source points and one inverse Compton scattering source point. Ten beam lines will be fully instrumented and maintained by the SRC. Monochromators will span the spectral range from about 4 to 1200 eV; there are plans to develop a soft x-ray crystal monochromator to extend the range to 4000 eV. Beam lines and monochromators will be available to users on a request-for-time basis. Since no single monochromator is able to span the entire range made available by Aladdin, requests for beam time should be specific on the choice of monochromator or the spectral range needed.

In addition to the ten facility beam lines, thirteen beam lines are being implemented by groups of users, called participating research teams (PRTs), each with its own specific purpose. Access to these instruments will be possible through negotiations involving the SRC director and the PRT involved.

When completed, Aladdin will have 23 monochromators operating on 21 beam lines, including five high-flux Seya-Namioka's (5–50 eV), three normal-incidence monochromators (including a 4-m ultrahigh resolution instrument), five toroidal grating monochromators (6–180, 225, and 700 eV), three high-resolution grasshoppers (20–1,000 eV), five high-resolution extended range grasshoppers (5–1500 eV), and a soft x-ray emission spectrograph. In addition, one x-ray crystal/grating (800–4000 eV) instrument has been authorized and a second is proposed.

Special facilities planned include an inverse Compton scattering line; a facility to handle transuranic, radioactive materials; soft x-ray lithography; ultraviolet and soft x-ray photoelectron spectroscopy systems with angle-integrated and angle-resolving capabilities; circular and magnetic circular dichroism; reflectance and absorption spectroscopies; and photon stimulated desorption.

Aladdin will operate—and Tantalus does operate—as a dedicated synchrotron source on a five day per week schedule with 48.5 h of beam time available for research. As with other national facilities, the user is responsible for the operation and the safety of his own instrumenation. The operation of the laboratory facilities is overseen by the SRC staff. The Physical Sciences Laboratory (PSL) of the University of Wisconsin provides the necessary support for the users, including computer capabilities (a VAX 11/780), purchasing services, mechanical and electrical engineering services, an outstanding machine shop, a library, and a stockroom. Housing is available at the PSL Guest House.

For additional information contact E. M. Rowe, Director, Synchrotron Radiation Center, 3725 Schneider Drive, Route 4, Stoughton, WI 53589.

E. NBS Synchrotron Radiation Facility, National Bureau of Standards, Gaithersburg, MD

The Synchrotron Ultraviolet Radiation Facility (SURF-II) at the National Bureau of Standards is a 280-MeV electron storage ring used as a dedicated light source in two areas of science: radiometry and experimental physics. Since the facilities for each of these two uses are for the most part independent, they are described separately.

The radiometric facilities fall into two classes: calibration and radiometric standards. SURF-II is an ideal light source for calibration since it is a single-magnet accelerator with a perfectly circular orbit. This feature allows the spectral distribution from the ring to be calculated with an accuracy of 2%. The calibration beam line consists of a white light port with accurate baffling to ensure a well-defined light beam. The beam light is equipped with a two-axis, two-transition gimbal on which a vacuum chamber or windowed instrument can be mounted. After an instrument is mounted, it is rotated about its entrance slit so that the light beam is scanned over its entire optical surface. For instruments which do not have their own vacuum envelope, e.g., rocket-borne or space-shuttle spectrometers, the beam line can be attached to a large vacuum chamber ($4 \times 4 \times 8$ ft) capable of attaining 10^{-8} Torr. A two-axis goniometer in the chamber again allows the mounted instrument to be rotated and the entire optical surface to be calibrated.

The radiometric standards beam line is used primarily for the calibration of photodiodes which are sold by NBS. It consists of a toroidal grating monochromator to disperse the light, a double ionization chamber to measure absolute photon intensity, and the diode chamber. Each diode is calibrated as a function of photon energy and is available as a secondary photometric standard. The calibration covers the photon energy range from 5 to 100 eV.

The facilities for experimental physics consist of three beam lines equipped with four monochromators. The first instrument is a high-flux, normal-incidence monochromator equipped with a differential pumping chamber to allow windowless gas-phase experiments. A pressure of 10^{-4} Torr can be maintained in the experimental chamber while the ring is operating. The spectral range is from 350 to 2000 Å, with a resolution of 0.05 Å. The maximum intensity is 10^{11} photons per second out of the exit slit.

The second instrument is a grazing-incidence, Rowland circle monochromator with an experimental chamber designed for reflectivity measurements. It covers the range from 80 to 800 Å, with a resolution of 0.15 Å. A gimbal in the experimental chamber allows a channeltron electron multiplier detector to be scanned about the sample.

The third monochromator has a range of 165 to 500 Å, with a resolution of 1 Å and an output of 10^{9} photons per second on the sample in a 2-mm-diam spot. A reentrant arrangement allows the sample to be placed within 2 cm of the slit. The experimental chamber contains a cylindrical mirror analyzer for surface-science studies. Both electron and ion emission from well-characterized surfaces can be studied.

The fourth monochromator is similar to the third one, but with a spectral range from 300 to 1000 Å. There is no permanent experimental chamber attached to it.

All these instruments are equipped with dedicated computers for experimental control and data acquisition.

Several monochromators are under construction. One is for a new radiometry facility which will also be available for experimentation. The second is a new high-flux, ultrahigh-vacuum monochromator to replace the surface-science facility. This instrument was being installed during the fall of 1983. Finally, a normal incidence monochromator with a resolving power of 10^{5} is scheduled to be in operation by the summer of 1984.

For additional information contact R. P. Madden, or D. L. Ederer, National Bureau of Standards, Washington, DC 20234.

III. FACILITIES FOR MICROANALYSIS, MICROFABRICATION, AND SURFACE STUDIES

The five facilities described in this section provide a great variety of sophisticated devices for probing, characterizing, and altering the structures of materials, and for preparing new materials and new structures. Surfaces and microstructures command a large share of the effort. It is worth noting that these facilities allow numerous powerful techniques to be brought to bear simultaneously on a single problem.

Figure 2 shows a small section of an array of resonant elements—dipole openings in a gold film deposited on calcium fluoride—fabricated at NRRFSS (see Sec. A below). The array acts as a band rejection transmission filter in the mid-infrared (7–9 μ). The primary resonant frequency is one-hundred times higher than any previously reported.

A. National Research and Resource Facility for Submicron Structures, Cornell University, Ithaca, NY

In 1977 the National Science Foundation established a National Research and Resource Facility for Submicron Structure (NRRFSS) to help advance submicron science and technology. The specific objectives of NRRFSS are: (1) to promote and carry out research to advance the art of submicron fabrication technology, and to train scientists and engineers in this field; (2) to provide a resource primarily for use by the university community to fabricate advanced devices or research structures which require submicron dimensions; (3) to stimulate innovative research outside the electrical engineering device community which will shed light on fundamental physics or materials problems limiting submicron technology; and (4) to keep the technical community informed on progress at the Facility.

Microfabrication research at NRRFSS involves about one hundred Cornell graduate students representing about eight departments and thirty-five faculty members. In addi-

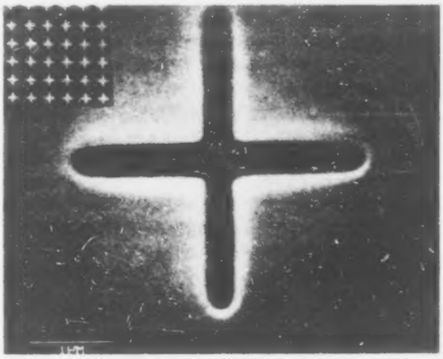

FIG. 2. A small section of an array of resonant elements fabricated at NRRFSS. Enlargements of one element, 3 μ long, also shown.

tion there are currently about thirty approved user projects outside Cornell. The Cornell research includes both facility development research and user research. The facility development research emphasizes enhancement of equipment and techniques in advanced lithography and dry pattern transfer processing as well as thin-film growth, deposition, and modification and, to a lesser extent, advanced device technologies and thin-film electrical, chemical, and structural analysis. Both facility development research and user research projects are initiated by a proposal review process.

For additional information contact E. D. Wolf or R. A. Brown, NRRFSS, Knight Laboratory, Cornell University, Ithaca, NY 14853.

B. The Center for Microanalysis of Materials, University of Illinois, Urbana, IL

It is not possible for an individual group to support equipment and maintain an interest in all of the techniques of microanalysis. The result is that, in general, a research group specializes in a particular characterization technique and tailors its research to it. The University of Illinois has adopted a different approach: instrumentation for microcharacterization of materials has been gathered into the Center for Microanalysis of Materials that operates as a facility for all of the materials research programs on campus and many collaborative research programs with other universities and laboratories.

The Center has transmission electron microscopes, scanning electron microscopes, a scanning transmission electron microscope, electron microprobes, scanning Auger microscopes, secondary ion microprobes, an x-ray photoelectron spectroscopy unit, rotating and fixed anode x-ray sources fitted with instrumentation for EXAFS, topography, small-angle scattering and all standard x-ray methods, and an accelerator for backscattering spectroscopies. Most of these instruments are modern commercial machines fitted with a wide range of accessories and instrumentation. In addition the Center has extensive facilities for specimen preparation. The Center is operated by a staff of about a dozen professionals/academics who guide and collaborate in research, maintain the equipment, and give instruction for its use.

More than a hundred faculty members on the University of Illinois campus carry out research in materials science. The Center for Microanalysis of Materials provides them with the unique opportunity to use almost any microanalytical technique, or combination of techniques, to characterize their samples.

A flexible program of interaction with other institutions is also maintained. For additional information contact J. A. Eades, Materials Research Laboratory, University of Illinois, 104 S. Goodwin, Urbana IL, 61801.

C. ORNL Surface Modification and Characterization Collaborative Research Center, Oak Ridge, TN

The Oak Ridge National Laboratory Surface Modification and Characterization Collaborative Research Center (SMAC) is a facility for cooperative research involving university and industrial scientists working with ORNL personnel on problems of mutual interest. The goal of the center is to provide and maintain advanced processing and characterization techniques for *in situ* alteration and analysis of near-surface properties of a wide range of materials.

The materials processing capabilities of the Center feature ion implantation doping, ion beam and laser mixing, and pulsed-laser processing. These are all nonequilibrium processing techniques capable of achieving new and often unique materials alterations not possible with equilibrium processing methods. The *in situ* materials characterization capabilities emphasize ion scattering and nuclear reaction analysis, ion channeling, surface analysis techniques (LEED, Auger, etc.), and other property measurements such as electrical resistivity and optical reflectivity.

The SMAC facility is equipped with beam lines from positive-ion analysis accelerators and a high-current ion implantation accelerator integrated into common ultra-high-vacuum chambers (10^{-10} Torr) which contain surface analysis instruments, solid-state detectors, and UHVgoniometers and sample holders, as well as optical windows which allow *in situ* laser processing. With these facilities it is possible to alter materials properties in UHV by ion beam and laser processing at sample temperatures from 4 to 1,300 K, and to analyze the materials in place. The ion accelerators include a 2.5-MeV Van de Graaf, a 200-keV high-current implantation accelerator, and a 1.7-MeV tandem accelerator, with both duoplasmatron and heavy-ion sources. The latter is scheduled for operation in 1984. A wide range of high-powered lasers is available, including ruby, Nd:Yag, and KrF lasers (15×10^{-9} s pulse duration time); a mode-locked Nd:Yag laser (30×10^{-12} s pulse duration time); and a cw Ar ion laser. With these laser sources it is possible to achieve heating and cooling rates that vary from approximately 10^6 to approximately 10^{12} °C per second in the near-surface region.

Facilities in the Center are being expanded to accommodate more users. For additional information contact B. R. Appleton, Solid State Division, ORNL, Oak Ridge, TN 37830.

D. SHaRE Program, Oak Ridge National Laboratory, Oak Ridge, TN

The SHaRE Program is a collaborative research venture in materials science between the research staff of ORNL and the research staff at both universities and industrial laboratories. Managed by Oak Ridge Associated Universities, its purpose is twofold: (1) to permit ORNL research staff members to carry out additional research relevant to the Department of Energy programs that would not ordinarily be possible; and (2) to make available to university staff and industrial researchers sophisticated research equipment at ORNL which is not available in their home institutions.

All research sponsored at ORNL under the SHaRE program is collaborative, with at least one ORNL staff member and one senior researcher from the outside institution having joint responsibility for successful completion of each project and for publication of the work.

From its inception in late 1978, the SHaRE program has concentrated on the application of advanced microanalytical techniques to research areas in materials science. Centered in the Metals and Ceramics Division, the facilities used under the SHaRE program include the analytical electron microscopes, the high-voltage electron microscope facility, the Auger electron spectrometry/surface microanalytical apparatus, the Van de Graaf nuclear backscattering equipment, and the computer facilities. Once a project is established as a collaborative SHaRE program, there is no charge for the use of the facilities. Access to the program requires submission of a proposal which involves an interested ONRL collaborator.

For additional information contact E. A. Kenik, Metals and Ceramics Division, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, TN 37830.

E. Regional Instrumentation Facility (CRISS), Montana State University, Bozeman, MT

The regional Instrumentation Facility at the Montana State University Physics Department (CRISS: Center for Research in Surface Science and Submicron Analysis) is devoted principally to basic and applied research in surface physics and chemistry. The main instrumentation includes: (1) a scanning Auger microprobe; (2) a high-resolution electron-energy-loss spectrometer with double-pass monochromator and analyzer; and (3) an ESCA system with Al/Mg double-anode x-ray head and hemispherical analyzer; the ESCA system is housed in the same vacuum as (2).

A singular advantage of this arrangement is the possibility of doing ELS and ESCA experiments in conjunction. The ESCA analyzer can do ion scattering spectroscopy in conjunction with the ion gun. The chamber supports a SIMS add-on based on a quadrupole mass analyzer. A third vacuum chamber supports a low-resolution (5-μ beam size) scanning Auger spectrometer and a He-discharge lamp for Ultraviolet Photoemission Spectroscopy. The laboratory also has the usual support facilities.

Although the advice and assistance of the staff are available to whatever extent necessary for effective execution of the experiments, the laboratory is operated primarily as a user facility, and the users are expected to plan and execute their own experiments, devoting the necessary time (from 1 to 3 days) to learn the operation of the equipment. The user's stay at the facility is generally from one to three weeks.

The staff includes a director, two staff scientists, a technician, and an administrative assistant. For additional information contact G. J. Lapeyre, Physics Department, Montana State University, Bozeman, MT 59717.

IV. ELECTRON MICROSCOPES

High voltage and ultrahigh resolution in electron microscopy require large installations. The three installations described here provide advanced capabilities for users. An example of the work is shown in Fig. 3, which is a micro-

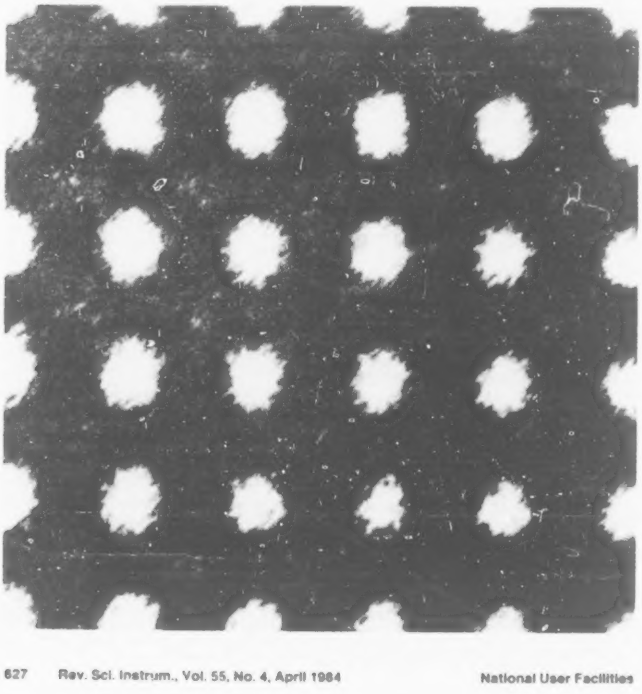

FIG. 3. Micrograph of zirconium dioxide with atomic resolution, taken on the JEM ARM-1000 at the National Center for Electron Microscopy.

graph of zirconium dioxide with atomic resolution. All atomic positions in a (0 0 1) projection are shown. The photograph was taken on the JEM ARM-1000 at the National Center for Electron Microscopy.

A. Facility for High Resolution Microscopy, Arizona State University, Tempe, AZ

The Facility for High Resolution Microscopy in the Center for Solid State Science at the Arizona State University is supported by the National Science Foundation and the State of Arizona. The goals of the Facility are to advance the methods and instrumentation of electron microscopy; to apply new research methods to the structural analysis of solids, particularly in the areas of materials science, solid-state physics, solid state chemistry, and geology; and to provide high-resolution research facilities for use of scientists and engineers from the solid-state science community at large. In addition, the Facility conducts topical research conferences and advanced electron microscopy schools each January.

The principal research topics of current interest are high-resolution imaging of surfaces and interfaces, electron-loss spectroscopy, microdiffraction, and energy dispersive x-ray spectroscopy. There are, at present, six electron microscopes at the facility, including two field-emission-source instruments (EM400/ST and HB-5) and a fixed-beam imaging instrument with 2.5-Å resolution. The field-emission-source instruments have been shown capable of high coherent microdiffraction from specimen areas as small as 5 Å, and microspectroscopy from areas about 10 Å in diameter. These experimental methods are being applied to an increasing number of intriguing problems, particularly in the areas of electronic materials, surfaces, and catalysts.

During the last year, more than twenty outside scientists conducted research at the Center with the assistance of an on-site support staff, and about forty on-site research programs made use of the Facility.

The topic of the January 1983 Research Conference at the Facility was High Resolution Imaging and Microanalysis of Surfaces. The conference topic for January 1984 is High Resolution Structural and Chemical Analysis of Boundaries and Interfaces.

For additional information contact the Director, Facility for High Resolution Electron Microscopy, Center for Solid State Science, Arizona State University, Tempe, AZ 85287.

B. National Center for Electron Microscopy, Lawrence Berkeley Laboratory, Berkeley, CA

The National Center for Electron Microscopy (NCEM) is primarily a high-voltage electron microscope facility with instrumentation designed for ultrahigh resolution or dynamic *in situ* imaging of materials. The Center is supported by the U. S. Department of Energy, and its instruments have been designated as user facilities.

Among the unique microscopes in the NCEM is a Kratos EM-1500, the only instrument in the U. S. which provides accelerating voltages in the 1200–1500-kV range. It features both a top-entry goniometer stage for high-resolution work and a side-entry stage for dynamic *in situ* and environmental cell studies. Depending upon the choice of specimen holder, the sample can be viewed over a plus or minus 45 deg tilt angle, at temperatures ranging from ambient to 850 °C and with various gaseous environments up to 1 atm pressure. Dynamic events can also be recorded on video tape. The operating pressure in the optical column can be brought to 10^{-7} Torr and the microscope has demonstrated a point-to-point resolution of about 3 Å.

A second instrument is the JEM ARM-1000, the only instrument of its kind in the world, providing a point-to-point resolution of 1.7 Å or better over all operating voltages up to 1000 kV. It has a top-entry goniometer stage with 45 deg biaxial tilting and height adjustment which, in addition to variable focal length, enables convergent beam electron diffraction patterns to be taken from the same specimen areas imaged in high resolution. Operating pressures are in the 10^{-8}-Torr range. The microscope makes extensive use of microprocessor control for precise operation, and has very high brightness (10^{6} A/cm^2 ster) due to its lanthanum hexaboride filament design.

Other microscopes within the NCEM include a JEOL JEM 200CK with an ultra-high-resolution goniometer and a Hitachi HU-650 high-voltage electron microscope with hot stage and environmental cell. By September 1983 a new building addition should have been completed to house the remainder of the NCEM support equipment, including wet and dry specimen preparation laboratories, optical diffractometer, image analysis and processing hardware, and an on-site minicomputer-based image simulation laboratory to assist with micrograph interpretation.

Beam time of the NCEM microscopes is allocated after review and acceptance of research proposals submitted in advance. In accordance with Department of Energy policy, as long as the proposed work is of documented programmatic interest to the Department and the results are published in the open literature, there is no charge for use of the NCEM microscopes.

For additional information contact G. Thomas, Scientific Division, or K. H. Westmacott, Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, CA 94720.

C. HVEM-Tandem-Accelerator National User Facility at Argonne National Laboratory, Argonne, IL

The High Voltage Electron Microscope (HVEM)-Tandem Facility is a unique national research facility. It is supported by the U. S. Department of Energy and is available to scientists from industry, universities, and other national laboratories, after approval of submitted research proposals. The facility is operated by the Materials Science and Technology Division of ANL and provides a unique combination of capabilities for high-voltage electron microscopy, ion implantation/bombardment, and ion beam analysis. A number of side-entry stages permits *in situ* experiments in the temperature range from 10 to 1300 K *in vacuo*, and from ambient to 1300 K in noncorrosive gaseous atmospheres. Straining stages are available for deformation and fracture studies over a wide range of experimental conditions. The

HVEM/ion beam interface permits direct observation of the effects of electron and ion bombardment on materials in the microscope. The ion beam interface may be used with either a 300-kV ion accelerator or the 2-MV tandem ion accelerator. Calibrated dosimetry systems are available for both ion and electron beams.

Prime-time usage of the facility is divided approximately equally between ANL and non-ANL scientists. The facility staff is available during one or two shifts a day to instruct experimenters in the use of the equipment, and in some instances to participate in experimental programs. In general researchers are expected to become competent to operate the equipment. A course of lectures on high-voltage microscopy supplemented by lecture notes is available on video tape.

When not scheduled for use with the HVEM the 2-MV Tandem and the 300-kV accelerators are used separately from the microscope by the ANL staff. Outside users wishing to use the accelerators alone are requested to collaborate with the appropriate group of the Materials Science and Technology Division of ANL.

For additional information contact the Facility Secretary, Sheryl Ruffatto, Building 212, Argonne National Laboratory, Argonne, IL 60439.

V. OTHER FACILITIES

This section lists several facilities that do not fit in the foregoing categories. They are the Francis Bitter National Magnet Laboratory, which provides ultrahigh magnetic fields of various kinds; the Los Alamos Equation of State Library, which provides the latest information on matter under extremes of pressure and temperature; and the Combustion Research Facility, which provides powerful new capabilities for the study of combustion in engines and other systems.

A. The Francis Bitter National Magnet Laboratory, M.I.T., Cambridge, MA

The Francis Bitter National Magnet Laboratory is the largest facility in the world for generation of intense continuous magnetic fields. The Laboratory traces its origin to the work of Prof. Francis Bitter, who pioneered electromagnetic technology in the 1930's; it was organized as a national laboratory in 1960 and started its operation at the present site in 1963. The National Science Foundation has been sponsoring the Laboratory's operation since 1970.

The Magnet Laboratory's facilities are available to users free of charge. A variety of high-field magnets are provided, together with cryogenic measurement and data processing equipment. Experienced support staff is also available on a full-time basis to assist visitors with all aspects of their experiments. Research staff at the Laboratory can be consulted about problems in specialized areas.

The Laboratory features almost two dozen water-cooled (Bitter) magnets in five bore diameters from 3.3 to 24.8 cm, with fields as high as 25 T in a 5.4-cm bore and 30 T in a 3.3-cm bore.

All fields are calibrated to 0.1% and are repeatable and stable to 0.05% short term, and 0.1% long term. Time stability of a few parts in 100 000 can be obtained with a localized feedback system. This system makes it possible, for example, to do nuclear-magnetic-resonance experiments in spatially uniform fields and to reduce eddy-current heating in low-temperature experiments. At the other extreme, modulation fields of up to 0.5 T peak-to-peak at 7.5 Hz can be generated for use with ac signal processing in, for example, quantum oscillatory experiments. The dc fields can be swept continuously from zero to maximum in as little as 1 min or as much as 2 h. Field setting, sweep, and modulation are all under local control by the user.

Two new sets of magnets should become available soon: (1) a pulsed-field facility which offers fields up to 45 T with 10-ms duration in a 1-cm bore at 4.2 K (1.5-cm bore at 77 K); (2) a superconducting magnet with a 20-min sweep to a 15-T field and a 5-cm room temperature access.

Users have available to them a broad range of equipment and apparatus, including complete temperature control systems with a range from 1.5 to 300 K, helium-3 and dilution refrigerators, and a complete de Haas—van Alphen apparatus along with homogeneous fields up to 24 T.

There is a queue of approximately three months for reserved magnet time—which is assigned in blocks of 15 to 30 h, depending on the power required. First-time users, however, can usually be accommodated within several weeks, and all users have the option of requesting magnet time on a recurring, biweekly basis. There is a separate queue for the use of the hybrid magnets.

For additional information contact Larry Rubin, Francis Bitter National Magnet Laboratory, NW-1108, M. I. T., Cambridge, MA 02139.

B. The Los Alamos Equation-of-State Library (SESAME), Los Alamos National Laboratory, Los Alamos, NM

The SESAME Equation-of-State (EOS) Library is a standardized, computer-based library of tables of thermodynamic properties and FORTRAN subroutines developed and maintained by the Equation-of-State and Opacity Group of the Theoretical Division of Los Alamos National Laboratory.

The Library contains data for about 70 materials, including metals, minerals, polymers, mixtures, etc., as well as simpler atomic and molecular species. The Library is being offered to all interested users free of charge.

The thermodynamic data stored in the Library include tables of pressure P and energy E (and also, in some cases, of Helmholtz free energy A), each as a function of density and temperature. Besides total P, E, and A tables, in many cases separate tables of thermal, electronic, and ionic (including zero point) contributions to P, E, and A are available. The SESAME EOS Library also has opacity data with a low-temperature limit of about 1 eV.

For further information on the SESAME EOS Library, write to SESAME Library, T-4, MS B925, Los Alamos National Laboratory, Los Alamos, NM 87545. Users interested in the opacity data should contact A. L. Merts or M. F. Argo, T-4, MS B212, Los Alamos National Laboratory, Los Alamos, NM 87545.

C. Combustion Research Facility, Sandia National Laboratories, Livermore, CA

The Combustion Research Facility (CRF) at Sandia National Laboratories in Livermore provides scientists an opportunity to study all phases of combustion science and technology. Researchers from universities, industry, and other government laboratories are encouraged to use the many laboratory and computer facilities, and to collaborate with resident scientists studying the basic chemistry and fluid mechanics of flames, as well as combustion phenomena occurring in devices such an engines and coal combustors. Central to nearly all CRF research is the incorporation of the most advanced laser-based techniques, many of which are being developed at the facility.

One part of this program is supported by the Division of Materials Sciences, Office of Basic Energy Sciences, U. S. Department of Energy, to develop a better understanding of the degradation of ceramic coatings and metallic alloys in the hot, corrosive, particulate-laden environments often present in combustion systems. Here, too, the application of the latest optical techniques has been strongly emphasized. Examples of such techniques, which are either in development or in use to study relevant problems, are:

(1) *In situ* surface Raman spectroscopy, which provides nonintrusive, real-time measurements of the chemical compositions and structural phases of corrosion layers building up on the surfaces of exposed materials.

(2) Raman microscopy, wherein Raman spectra are obtained with 1-μ resolution for the detailed characterization of polycrystalline or amorphous materials typical of most corrosion layers.

(3) Sputter-induced photon spectroscopy, in which optical emissions from excited atoms sputtered from surfaces provide high sensitivity for detecting trace species, including hydrogen, in insulating as well as conducting materials.

(4) Sputter-Raman spectroscopy, in which Raman spectroscopy is used to determine the depth profile of corrosion layers as material is removed by sputtering.

For additional information contact Walter Bauer, Department 8340, Sandia National Laboratories, Livermore, CA 94550.

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APPENDIX B

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APPENDIX C

PRESENTATIONS TO THE MAJOR MATERIALS FACILITIES COMMITTEE

CONTENTS

FOREWORD

I. WORKSHOP: MARCH 17-19, 1984*

A. INTRODUCTION

Probing Matter with Electrons, Neutrons, and Photons
J. D. Litster, Massachusetts Institute of Technology

B. SCIENTIFIC OPPORTUNITIES WITH SYNCHROTRON RADIATION
D. W. Lynch, Iowa State University, Chairman

1. X-Ray Physics
   D. E. Moncton, Brookhaven National Laboratory
2. Scientific Opportunities with Vacuum Ultraviolet (Soft X-Ray) Synchrotron Radiation from Insertion Devices
   J. Stohr, Exxon Research & Engineering Company
3. X-Ray Microprobe Characterization of Materials: The Case for Undulators on Advanced Storage Rings
   C. J. Sparks, Jr., Oak Ridge National Laboratory
4. Synchrotron Radiation Research in Biology and Medicine
   K. Hodgson, Stanford University

C. SCIENTIFIC OPPORTUNITIES WITH NEUTRONS
R. J. Birgeneau, Massachusetts Institute of Technology, Chairman

1. Physics
   J. D. Axe, Brookhaven National Laboratory
2. Chemistry
   B. Fender, Institut Laue-Langevin

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* S. A. Rice, University of Chicago, and J. D. Litster, Massachusetts Institute of Technology, served as Co-Chairmen of a panel discussion on March 17.

3. Scientific Opportunities with Neutrons in Materials Science
   J. R. Weertman, Northwestern University
4. Application of Neutron Beam Research in Biology and Medicine
   P. B. Moore, Yale University

D. OVERVIEW OF RELATED REPORTS

1. Current Status of Neutron Scattering Research and Facilities the United States
   S. A. Werner, University of Missouri
2. Planning Study for Advanced National Synchrotron Radiation Facilities
   M. L. Knotek, Sandia National Laboratories

E. PROPOSED NEW AND UPGRADED FACILITIES FOR SYNCHROTRON RADIATION RESEARCH
   D. W. Lynch, Iowa State University, Chairman

1. Prospectus for a 6 GeV Synchrotron Source, Argonne National Laboratory
   Presented by K. L. Kliewer
2. Planned Evolution of the NSLS, Brookhaven National Laboratory
   Presented by D. E. Moncton
3. A Prospectus for a 6 GeV Dedicated Synchrotron Radiation Facility at Cornell University, Cornell High Energy Synchrotron Source
   Presented by B. D. McDaniel
4. The Advanced Light Source: Scientific Opportunities, Lawrence Berkeley Laboratory
   Presented by H. Grunder
5. SSRL's Planning for a New Synchrotron Radiation Facility including a 6 GeV Storage Ring, Stanford Synchrotron Radiation Laboratory
   Presented by A. I. Bienenstock and H. Wiedemann

F. PROPOSED NEW AND UPGRADED FACILITIES FOR NEUTRON SCATTERING
   R. J. Birgeneau, Massachusetts Institute of Technology, Chairman

1. The Argonne Neutron Plan, Argonne National Laboratory
   Presented by G. H. Lander
2. Guide Hall at the High Flux Beam Reactor, Brookhaven National Laboratory
   Presented by B. P. Schoenborn
3. WNR/PSR Experimental Hall Expansion, Los Alamos National Laboratory
   Presented by J. C. Browne

4. NBS Center for Cold Neutron Research, National Bureau of Standards
    Presented by J. M. Rowe
5. ORNL Presentation to the Major Materials Facilities Committee of the National Research Council, Oak Ridge National Laboratory
    Presented by R. M. Moon

G. THE ROLE OF NATIONAL LABORATORIES IN MATERIALS RESEARCH

1. The Role of National Laboratories in Materials Science Research
    H. Postma, Oak Ridge National Laboratory
2. Synchrotron R&D at the Defense Programs Laboratories
    P. E. Coyle, Lawrence Livermore National Laboratory
3. Overview of the Recent ERAB Report on Materials Research and Development
    R. H. Pry, Gould, Inc.

II. COMMITTEE MEETING MAY 3, 1984

OTHER KINDS OF MAJOR MATERIALS FACILITIES
A. Narath, AT&T Bell Laboratories, Chairman

1. High Magnetic Field Research in the U.S. - Status of the National Facility and Future Opportunities
    P. A. Wolff, Massachusetts Institute of Technology
2. The Materials Research Laboratory Program
    W. D. Nix, Stanford University
3. Toward an Advanced Materials Processing and Analysis Center (AMPAC)
    H. K. Bowen, R. M. Latanision, and J. B. Vander Sande, Massachusetts Institute of Technology

III. LIST OF RELEVANT REPORTS

IV. PARTICIPANTS AT THE WORKSHOP, COMMITTEE, AND PANEL MEETINGS

V. CORRESPONDENTS

APPENDIX D

PRESENTATIONS TO PANELS
OF THE MAJOR MATERIALS FACILITIES COMMITTEE

Neutron Scattering Panel

National Academy of Sciences, Washington, D.C.
February 26-27, 1984

Argonne National Laboratory: R. Kustom, G. Lander
Brookhaven National Laboratory: V. Emory, B. Schoenborn
Los Alamos National Laboratory: J. Browne, R. Silver
National Bureau of Standards: M. Rowe, C. Han
Oak Ridge National Laboratory: H. Mook, R. Moon, Jr.
Department of Energy Perspective: L. Ianniello
National Bureau of Standards Perspective: R. Kammer

Synchrotron Radiation Panel

Molecular Biology Institute
University of California at Los Angeles
February 28, 1984

A 1.6 GeV Storage Ring: D. Shirley, D.Attwood, Lawrence Berkeley Laboratory
A 6 GeV Storage Ring*: A. Bienenstock, H. Wiedemann, Stanford Synchrotron Radiation Laboratory; D. Mills, B. Battermann, Cornell High Energy Synchrotron Source; M. Blume, S. Krinsky, Brookhaven National Laboratory; K. Kliewer, Y. Cho, Argonne National Laboratory

* The speakers shared the time describing science for a 6 GeV machine; each devoted a modest fraction of his presentation to site-specific plans.

Other Specialized Facilities Panel

National Academy of Sciences, Washington, D.C.
March 8, 1984

UV Laser Sources: G. Rosenblatt, Los Alamos National Laboratory
National Magnet Laboratory: P. Wolff, Massachusetts Institute of Technology
Muon Sources: R. H. Heffner, Los Alamos National Laboratory

Dr. SEITZ. Thank you.

As our report emphasizes, cold neutron research impacts many areas of materials research and technology. To quote again from our committee's recommendations, "Cold neutron facilities are urgently needed to address the rapid expansion of neutron applications in materials science, chemistry and biology. Many central problems in these sciences can only be solved using new instruments with cold neutron beams."

I want to emphasize, as I had not and should have a little earlier, that we looked into the biological applications, and they are particularly important in the field of polymeric science and in the large—for studying the large biological molecules.

Finally, I'd like to speak about cost effective use of the Nation's large facilities. The proposal from the National Bureau of Standards will provide a very major capability at a relatively low cost, far lower than the cost of a completely new unit. A new unit would cost at least five times as much and require at least a decade, whereas the proposal we are supporting here would come on line in a relatively short time, say, 3 or 4 years at the outside. You will find again in this report estimates of the time required to make these renovations and upgradings.

The proposed investment to serve the demonstrated need for cold neutron research is quite modest with existing and approved investment in Western Europe and Japan, which totals something over $200 million at present.

I think I will terminate there.

[The prepared statement of Dr. Seitz follows:]

INVITED TESTIMONY BY

Frederick Seitz
Co-Chairman, Major Materials Facilities Committee
National Research Council

BEFORE THE

Committee on Science and Technology
U.S. House of Representatives

AUTHORIZATION HEARING ON THE NATIONAL BUREAU OF STANDARDS' COLD NEUTRON PROGRAM

Wednesday, March 6, 1985
Room 2325, Rayburn House Office Building

INVITED TESTIMONY BY

Frederick Seitz
Co-Chairman, Major Materials Facilities Committee
to the
House Committee on Science and Technology

Wednesday, March 6, 1985
Room 2325, Rayburn House Office Building

Thank you, Mr. Chairman. I am pleased by the opportunity to testify today on the recent report of the National Research Council which sets forth priorities for federal support of major materials research facilities.

My name is Frederick Seitz. I have been a member of the National Academy of Sciences since 1951 and served as its President from 1962 to 1969. Since then I have been at Rockefeller University, serving as President from 1968 to 1978.

As many of you no doubt know, about a year ago the National Academy of Sciences was asked by the Office of Science and Technology Policy to organize a committee to review U.S. needs for Major Materials Facilities, and to establish priorities for the provision of such facilities. Dean E. Eastman and I served as Co-Chairmen of that committee; a list of its members is attached. The Committee completed and delivered its report titled "Major Facilities for Materials Research and Related Disciplines" to OSTP and the sponsoring federal agencies, DOE and NSF on July 24, 1985.

Let me outline for you this afternoon the conclusions and recommendations of our report, particularly those most relevant to the proposed NBS budget for Fiscal Year 1986.

The report deals solely with major facilities. That was the Committee's charge. The facilities considered were those that are national in scope, with initial costs on the order of $5-10 million or more, intended primarily for research on materials. However, the Committee noted that materials research done on a laboratory scale is equally vital to the future strength of U.S. materials research. Support of laboratory-scale science is complementary to, not competitive with, the support for major facilities recommended.

A continuing concern throughout the Committee's deliberations was the possible misinterpretation of its report. As is emphasized several times the knowledge generated by materials research comes from diverse research styles and performers, each vital to the total effort and each complementary to the other. Those varying styles must each be well supported, for the health of the total effort in materials research. Therefore, the recommendations in the report should be read and interpreted for what they are: a statement as to priorities solely for major materials facilities. The Committee did not address, and the report does not imply, any judgments on the total spectrum of work embraced by materials research.

The report presents priorities both for new facilities and new capabilities at existing facilities with initial cost of at least $5 million. The new facilities in order of priority are: a 6 GeV Synchrotron Radiation Facility; an Advanced Steady State Neutron Facility;

a 1 to 2 GeV Synchrotron Radiation Facility; and a High Intensity Pulsed Neutron Facility. The new capabilities at existing facilities in order of priority are: centers for cold neutron research, incorporating guide halls and instrumentation; insertion devices on existing synchrotron radiation facilities; an experimental hall and instrumentation at the Los Alamos National Laboratory Pulsed Neutron Source; upgrading of the National Magnet Laboratory; and enriched pulsed neutron targets.

With respect to cold neutron research, which is germane to the NBS budget, I would like to quote from the executive summary "...the immediate implementation of at least one instrumented cold neutron guide hall is necessary to provide forefront capability." In fact, as noted above, the provision of an internationally competitive cold neutron research capability was the highest priority recommendation among opportunities for new capabilities at existing major materials facilities in the United States. The report establishes both the urgent need for this capability and the opportunity that exists at the National Bureau of Standards to meet this need in a cost effective manner.

During our deliberation, NBS was asked to present their proposal both to the subpanel on neutron scattering and to the full committee. Their presentation, along with all of the presentations for new or enhanced facilities, is published as an appendix to the committee report. This presentation is the basis of the testimony that I will give today.

First, let me say on behalf of the committee that we are very pleased to see this proposal in the budget for the Fiscal Year 1986, and hope that you will be able to act favorably on this request which will allow work on

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there are difficulties in the communication between the various parties that are working in the area.

This brings me to my last point, and that is the support of the Bureau's initiative in advanced ceramics. The generation of a technology base—in other words, the development of the scientific understanding and the measurement techniques that are involved, the measurement of what the understanding consists of, the evaluation of the data collected in these measurements, and finally, the standardization of materials, either standard reference materials or other standards—I think, is key to success. These points to me seem to fit exactly with the mission of the National Bureau of Standards.

The Bureau has a general program at the present time underway in ceramics, but it's a very specific program with commitments that go back many years. For example, there's a vigorous program in the generation of crystal data and the generation of x-ray diffraction information, and there's a phase equilibrium evaluation program; there is also work on nondestructive evaluation, and work on fracture that's been going on for some time. All these are very important and should not be stopped. But that isn't enough in itself.

I think there is need to build on this base to enhance the excellent position that the Bureau has and to build forward on that. This type of broad collection of information, particularly the emphasis on measurement methods and evaluation of these methods, is not being done by any other agency. Most of the other laboratories that are engaged in advanced ceramic research are the mission-oriented parts of our Government; the laboratories in the Department of Defense, Department of Energy, and NASA all do a splendid job in their own areas, but they have a very specific mission and a very specific focus to follow.

I would say also that the Bureau has demonstrated an ability over the years to work with industry. I think they have a track record which shows that they can communicate what they've learned to industry and to universities. They have conferences, workshops, lots of publications, and industrial research associates present at the Bureau, and these are some of the means of interaction which I think have been effective and which work well. There's an openness about dealing with the Bureau that is very satisfying and comforting to people in industry and in universities. Any one of us can drive our car up and park behind the materials building and walk in and talk to the people. It's open and the communications are very effective.

So, in summary, I would conclude by saying advanced ceramics are here, they're important; and, second, I think that the Bureau is singularly qualified to carry out this development of a technology, measurement, and evaluation base for advanced ceramics.

Thank you very much.

[The prepared statement of Dr. Prindle follows:]

a 1 to 2 GeV Synchrotron Radiation Facility; and a High Intensity Pulsed Neutron Facility. The new capabilities at existing facilities in order of priority are: centers for cold neutron research, incorporating guide halls and instrumentation; insertion devices on existing synchrotron radiation facilities; an experimental hall and instrumentation at the Los Alamos National Laboratory Pulsed Neutron Source; upgrading of the National Magnet Laboratory; and enriched pulsed neutron targets.

With respect to cold neutron research, which is germane to the NBS budget, I would like to quote from the executive summary "...the immediate implementation of at least one instrumented cold neutron guide hall is necessary to provide forefront capability." In fact, as noted above, the provision of an internationally competitive cold neutron research capability was the highest priority recommendation among opportunities for new capabilities at existing major materials facilities in the United States. The report establishes both the urgent need for this capability and the opportunity that exists at the National Bureau of Standards to meet this need in a cost effective manner.

During our deliberation, NBS was asked to present their proposal both to the subpanel on neutron scattering and to the full committee. Their presentation, along with all of the presentations for new or enhanced facilities, is published as an appendix to the committee report. This presentation is the basis of the testimony that I will give today.

First, let me say on behalf of the committee that we are very pleased to see this proposal in the budget for the Fiscal Year 1986, and hope that you will be able to act favorably on this request which will allow work on this vital project to proceed. The NBS proposal is based on the availability of a large volume cold neutron source that will be installed in the 20 Megawatt Research Reactor, a project that was approved in the budget for Fiscal Year 1985. The special features of this cold neutron source present an opportunity to develop a truly national facility, that can help to fill the critical gap in U.S. cold neutron research capability identified by our committee. The industrialized nations in Western Europe have already developed extensive capability in this new research area.

The proposal before you now is to allow development of a large cold neutron research facility, to be located adjacent to the existing reactor building. One of the special properties of cold neutrons that make this such an opportunity is the fact that cold neutrons can be transported over many tens of meters with very small losses in intensity. This allows many instruments to be served by the cold neutron source, provided that the source geometry allows the installation of many neutron "guides" well separated in angle. Since the NBS reactor was designed to allow such access, provision of adequate experimental space such as that proposed will provide at least 15 experimental stations, a number that will allow for development of the instruments required to give U.S. researchers access to the latest types of neutron instrumentation. Our committee concluded that access to such instrumentation is essential if U.S. materials research is to match the growing capabilities in Europe and Japan.

The proposed facility would be operated as a national user facility, with equal access for all American researchers. This is an important aspect of this and any other major facilities that may be approved. They must provide their measurement technology to the entire nation, so that the best use is made of what are, of necessity, limited resources. The proposed mode of operation provides 2/3 of the operating time on the eleven experimental stations to general users, with the time to be allocated by a Program Advisory Commitee with wide membership. The remaining 1/3 of the time would be available for NBS use. In addition, space for at least 4 experimental stations will be made available for development by outside parties such as Participating Research Teams (PRT's). These stations would be designed, constructed and maintained by the PRT in return for a guarantee of 2/3 of the available time. The remaining 1/3 of the time would be available to general users. This mode of operation provides for both the general user, who needs a limited amount of time on many different instruments, and the more specialized user, who needs guaranteed access to a specific instrument for long periods of time. The arrangement ensures the most efficient utilization of the facility by all interested researchers, and provides the broad range of experimental techniques that are required to allow the U.S. to establish a competitive position in this critical area of materials science.

As the report emphasizes, cold neutron research impacts on many areas of materials research and technology. To quote again from our committee's recommendations: "...Cold neutron facilities are urgently needed to address the rapid expansion of neutron applications in materials science, chemistry and biology. Many central problems in these sciences can only be solved using new instruments with cold neutron beams." The NBS proposal contains the instruments that are required to serve this diverse need which extends over virtually all of our materials-based sciences ranging from solid state physics and metallurgy to chemistry and biotechnology. They proposed eleven experimental stations for the general user community in the broad general areas of instruments to study microstructure (in e.g. metal alloys, polymers and composites, biological assemblies and ceramics); the very slow motions of molecules (e.g. polymers in solution, biomolecules in solution, molecules in and on the surface of catalysts, and ions in new battery materials); the properties of materials with phase transitions, the dynamics of novel magnetic materials and the coupling of different types of motion); the atomic-scale behavior of impurities in metals and of molecules in chemical compounds (e.g. the trappings of hydrogen at impurities in metals, the movement of molecules diffusing in chemical compounds and the motions of atoms or molecules in liquids); and the distribution of atoms in solids (e.g. depth profiling of key impurities in semiconductors, the structure of protective films on electronic devices and the presence of trace amounts of elelments such as hydrogen in bulk materials). As you can see from this description, this facility would serve a very broad array of users and provide them with an essential measurement technology that is not currently available in this country.

Finally, I would like to speak about cost-effective use of the nation's large facilities. The NBS proposal will provide this capability at a cost much less than would be required to build a totally new facility (our estimate is that a new facility would cost at least 5 times as much as this proposal and require more than a decade to develop). The proposed investment to serve the demonstrated need for cold neutron research is quite modest when compared to the exisitng and approved investment in Western Europe and Japan (over $200 million). This proposal builds on existing facilities and programs, in order to make the best possible use of limited resources, and to provide the basis for needed improvements in our nation's neutron research capability in the future. The research reactor at NBS is part of an existing Center for Materials Science that is engaged in a broad range of materials research. Such a location would provide an optimum environment for the new capabilities to be provided.

MAJOR MATERIALS FACILITIES COMMITTEE

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BIOGRAPHY OF FREDERICK SEITZ

President Emeritus Frederick Seitz of The Rockefeller University, a former president of the National Academy of Sciences, is a distinguished physicist and educator who has held key government posts for over three decades. In 1973 he received the National Medal of Science, the nation's highest award in science, for his contributions "to the foundation of the modern quantum theory of the solid state of matter." In 1983 he received the Fourth Vannevar Bush Award presented by the National Science Board of the National Science Foundation and the R. Loveland Memorial Award of the American College of Physicians.

From 1978 to 1983 he served as vice chairman of the board of trustees of the Memorial Sloan-Kettering Cancer Center.

Dr. Seitz was appointed president of The Rockefeller University in 1968. Under his administration, new basic research programs were started in reproductive biology, cell biology, molecular biology, and the neurosciences as well as new clinical investigations at the University's 40-bed research hospital. A joint M.D.-Ph.D. program in cooperation with Cornell University Medical College was initiated whereby highly qualified graduate fellows can obtain both degrees in six years. A 1,000-acre Field Research Center for Ecology and Ethology was established at Millbrook, New York, where behavioral and biological scientists study a wide range of natural phenomena related to animal behavior and environmental biology.

Also during his tenure, seven endowed professorships were launched; the University completed construction of the Tower Building, a 17-story laboratory and office complex; a new six-story Laboratory Animal Research Center and a 250-unit apartment complex were built; and the Rockefeller Archive Center was established in Pocantico, New York. Dr. Seitz played a major role in launching the first development program in the institution's history. He retired as president in 1978 and was succeeded by Joshua Lederberg. In 1981 the University awarded him an honorary doctor of science degree.

Frederick Seitz was born in San Francisco, California on July 4, 1911. He received the A.B. degree in mathematics from Stanford University in 1932 and the Ph.D. degree in physics from Princeton University in 1934 where he was a postdoctoral Proctor Fellow. While at Princeton, he and his teacher, Professor Eugene P. Wigner, developed the Wigner-Seitz method for calculating the cohesive energy of a metal, the first such calculation, based on the known properties of the atoms involved.

He served on the faculties of the University of Rochester (1935-1937), the University of Pennsylvania (1939- 1942), the

Carnegie Institute of Technology, now the Carnegie-Mellon University (1942-1949), and was a research physicist at the General Electric Laboratories (1937-1939).

In 1940 Dr. Seitz published The Modern Theory of Solids, a book which is generally regarded as having been a prime influence in the development of solid state physics, including the development of transistors. His second volume, The Physics of Metals, was published in 1943. He has been an editor and consultant to numerous scientific publications. He was the editor for the second Five Year Outlook for the National Academy of Sciences, and is consulting editor in solid state physics for the Encyclopedia of Science and Technology.

His career in public service began during World War II as a civilian member of the National Defense Research Committee and consultant to the Secretary of War. He was also the director of the training program in atomic energy at the Clinton Laboratories of the Oak Ridge National Laboratory from 1946 to 1947. His wartime research included work on ballistics, radar, and nuclear reactors.

Appointed professor of physics at the University of Illinois in 1949, he became department chairman in 1957, and dean and vice president for research in 1964. He served as president of the National Academy of Sciences on a part-time basis for three years before assuming full-time responsibilities in 1965. He was a member of the board of trustees of The Rockefeller University from 1966 to 1978.

Dr. Seitz was science advisor to the North Atlantic Treaty

Organization in Paris from 1959 to 1960 and was a member of the President's Science Advisory Committee from 1962 to 1969. He has been an advisor to the Office of Naval Research, the Office of Aerospace Research, the National Bureau of Standards, the Industrial College of the Armed Forces, the Bureau of Near Eastern and South Asian Affairs, the Defense Science Boards, the National Cancer Advisory Board, and The Smithsonian Institution, among other national and international agencies.

He is currently a member of the Council on Foreign Relations, the Committee to Maintain a Prudent Defense Policy, the Board of the Center for Strategic and International Studies of Georgetown University, and the New York City Commission for Science and Technology. He has served as chairman of the United States delegation to the United Nations committee on Science and Technology for Development, and as a member of the Secretary of State's Monitoring Panel for UNESCO.

He is former chairman of the board of the John Simon Guggenheim Foundation and of the Woodrow Wilson National Fellowship Foundation. He is a trustee of The American Museum of Natural History and of the Institute for International Education.

Among his numerous honors and awards, Dr. Seitz received the Franklin Medal in 1965, the Herbert Hoover Medal in 1968, the Defense Department Distinguished Service Award in 1968, the NASA Distinguished Service Award in 1969, the Compton Award, the highest award of the American Institute of Physics, in 1970, and the James Madison Medal of Princeton University in 1978. In 1979 he received his second NASA Distinguished Public Service Medal presented for his "dedicated service as chairman of the NASA Space Program Advisory Council from 1973 to 1977." In addition to Rockefeller, 26 universities in this country and abroad have awarded him honorary degrees.

Other memberships include the American Academy of Arts and Sciences, the Century Club, the Bohemian Club, the American Philosophical Society, the American Society for Metals, the American Institute of Mining, Metallurgy and Petroleum Engineers, the American Crystallographic Society, the Optical Society of America, the Washington Academy of Science, and a number of European scientific academies.

Dr. Seitz is married to the former Elizabeth K. Marshall. They reside in New York City.

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December 1984

Mr. **Walgren**. Thank you, Dr. Seitz. We appreciate that very much, and we will come back in conversation with you.

Mr. **Lundine**. Advanced ceramics is one of the most exciting new areas in materials science. These materials are already in use for packaging of electronic chips and growing new markets are envisioned in the areas of cutting tools, artificial human joints, and even automobile engines. Experts have predicted that what is now a few billion dollar world market will grow several-fold by the end of the century.

To be competitive in this rapidly growing area, the United States must solve the technical problems associated with commercialization of advanced ceramics. These are problems that can be properly addressed by the National Bureau of Standards.

No one is better qualified to tell us about this than Dr. William Prindle, director of administrative and technical services of the research and development division of Corning Glass Works. He has been president of the American Ceramic Society and has worked closely with the National Bureau of Standards in this area.

Mr. **Walgren**. Let me just go on down the line. Dr. Prindle.

Dr. **Prindle**. Mr. Chairman, members of the subcommittee, I will summarize the statement that I submitted in written form.

I come to you this afternoon as an individual from Corning, NY, where I am director of administrative and technical services for the Corning Glass Works, and also happen to be director of materials research at this time. I've been associated with various management positions in research and development in the ceramic industry throughout my professional career, and have been involved with various professional societies that are related to the ceramic industry, including the presidency of the American Ceramic Society, and currently the vice presidency of the International Commission on Glass. I've had a long period of association with the National Bureau of Standards, having visited there first in 1951 and, in the last 34 years, have had many opportunities to go back and have questions answered, to observe the people working in the laboratories, and to have some feeling for their capabilities and the direction in which they're headed. I was also Chairman of the Evaluation Panel of the National Research Council that reviews the activities of the Bureau's Inorganic Materials Division. More recently, I've been involved with the Phase Equilibrium Program at the Bureau.

I'm here to present my support for the proposed program increase for advanced ceramics. There are two points that I'd like to make—one, of course, is that advanced ceramics are important to the U.S. economy and to our more military position, and second, to endorse the Bureau of Standards initiative in the advanced ceramics area as being important, well conceived, appropriate to the Bureau's mission, and, I think, well deserving of support.

Without attempting to give a lecture on ceramics and why they're important, I think we're all aware of the information that's appeared not only in the popular press, but also in the technical press, regarding the properties of these materials, such as their hardness, and their strength. With regard particularly to their light weight, the strength-to-weight ratio is very attractive in many cases. They have resistance to corrosion and to high temperatures, and also, in many cases, special optical, electrical, and magnetic properties that make them quite desirable, sometimes the only materials that will solve certain problems.

The area of advanced ceramics includes what one might call electronic materials, structural materials, and hard wear-resistant materials. This would include in the electronic area such things as capacitor substrates, capacitor materials themselves in many cases, and insulators. In the structural area, there are many applications which relate to automotive engines, diesel engines, and gas turbines. Many of these are still on the horizon, and only recently have some efforts been made to commercialize some of these applications—piston tops, for example, turbo-charger rotors, valve guides, and exhaust ports in engines are things that can be done at this time to increase the effectiveness of engines by allowing them to operate at higher temperatures.

In the wear-resistant area, advanced ceramic materials are used as cutting tools and as dies for wiredrawing. Also special applications include oxygen sensors, use as nonmetallic magnets, and optical waveguides.

The question might be asked: If advanced ceramics are so good, why aren't they more widely used? That, of course, is the reason for the advanced ceramic initiative. There are some problems. The two key problems are reliability and reproducibility: Reliability in the sense that ceramic materials often fail catastrophically and unpredictably under stress. One might say that all ceramics ultimately die a violent death. The problem in reproducibility is due to what in my written comments I called production consistency. It's a matter of making ceramic parts the same way every time so that their properties, and their structure are consistent and, therefore, their performance is the same every time. Until these things can be controlled, there are going to be problems in the widespread exploitation of these materials.

A lot is being done in industry and in universities today to solve these problems. There's a tremendous amount of activity, more than ever before, to resolve these difficulties. But we need help in understanding the behavior of these materials, and the relationship between processing, structure, properties, and performance should be better understood. There was a statement made by Lord Kelvin, which I can't quote exactly, but the sense of it was that until we can actually measure scientific phenomena, we really don't understand them. And this is the point that I'd like to get across, that measurement is key to the effective use of advanced ceramic materials in the United States.

It's being done in a sort of a patchwork fashion at the present time. Various companies are making measurements, but typically in industry, a company will investigate only that area that fits their particular product and neglect other related areas; the same thing applies in a different sense at universities where professors and graduate students will usually explore a specific property or phenomenon. What is needed is a linkage or a connection, a broad underlying science and technology base to bring this all together to make it more useful to industry, and to universities as well. At the present time, this is an uncoordinated activity and, as a result,

Statement of Dr. William R. Prindle
Director of Administrative and Technical Services
Corning Research and Development Division
Corning Glass Works
Corning, New York

before the

Subcommittee on Science, Research and Technology
of the
Committee on Science and Technology
U.S. House of Representatives

March 6, 1985

Mr. Chairman, Members of the Subcommittee:

I appreciate the opportunity to appear before your subcommittee to discuss high-technology ceramics. I have two messages to bring you: First is my enthusiasm for this new generation of high-technology materials, advanced ceramics. Because of their special properties, they are beginning to appear in a wide range of new high-technology applications. The resulting impact on the U.S. economy, both direct and indirect, should be significant and will be strongly influenced by the degree of successful U.S. commercialization in this area. Second is my support for the programs at the National Bureau of Standards that will assist in the commercialization of these materials.

Before I proceed, permit me to introduce myself and to tell you about my relationship to the National Bureau of Standards. My name is Bill Prindle, and I am Director of Administrative and Technical Services at Corning Glass Works, a major producer of glass and ceramic components. Our products range from electronic components used in television sets and computers to aerospace windows, to glass fiber optical waveguides for advanced communication networks, to ceramic honeycomb structures that are for exhaust heat recovery in advanced automotive turbine engines. I am a past President of The American Ceramic Society. My relationship to the National Bureau of Standards goes back over a number of years. I served on the National Research Council Evaluation Panel for the Inorganic Materials Division at NBS from July 1970 to June 1976, chairing the panel during my last year. More recently I have been involved through The American Ceramic Society with a joint program between the Society and NBS on Evaluated Phase Diagrams. The Resource Committee, of which I was a member, is charged with the task of raising funding from industry to support the Society's portion of this program. I should add at this point that the industrial response supporting this program has been outstanding with over $1 million already pledged.

But now let me return to my message. I hardly need to emphasize the potential for advanced ceramics. The general excitement over ceramics - with applications ranging from optical communications to advanced automotive engines - is beginning to get as much press coverage in the United States as in Japan. In fact, in Japan this enthusiasm is so great, even among the general public, that it has been called "Ceramic Fever". But to accentuate this potential let me quote from a recent issue of Chemical & Engineering News (July 9, 1984) where Professor Eric A. Barringer of the Massachusetts Institute of Technology asserted that "any large U.S. chemical company that is not now active in the high-tech ceramics field or is not planning to enter the field in the near future must obviously be daft".

This market potential stems from the unique properties that ceramics possess which make them the best, or sometimes the only material of construction for a particular application. (These unique properties include: their lightweight and high relative strength; their extreme hardness; their resistance to wear, corrosion, and high temperatures; and their specialized optical, electrical and magnetic properties.)

For example, specialized dielectric and thermal properties make some ceramics the heart of new high-technology information systems; resistance to heat, wear, and corrosion, coupled with high relative strength, make other ceramics the materials of opportunity for advanced automotive engines and power generation systems. These are but two of the wide range of new markets where we will see ceramics in the future.

However, this market potential cannot be realized without a price. Currently, major technical barriers exist in the competitive commercialization of advanced ceramics. These barriers are related to reliability, production consistency, and the ability to tailor properties. Reliability is a major concern, stemming from the only negative trait of ceramics; their brittleness and propensity to unpredicted, catastrophic failure. Production consistency is related to the sophisticated processing required of these materials, making necessary greater control over raw materials, impurities, mixing, forming, and heat treatment. Finally, full utilization of the unique properties of ceramics only comes when we develop the understanding to be able to tailor the properties for a specific application.

As an industry we are addressing these technical barriers, but only as they relate to the specific materials or products we manufacture. To be successful we need an underlying technology base, particularly in generic understanding of the relationship of processing to structure, structure to properties, and properties to performance. We need measurement techniques and reference standards that allow us to develop our material specific processes, property data, and performance criteria.

No one company can provide the complete technology base needed due to the cost and time involved. A competent, unbiased body is needed to work out the measurements that all parties can use to describe their materials. Companies typically explore only areas related to their own products, and this information is proprietary. Accordingly, a patchwork of data is developed which is shared only when it can no longer be of value to competitors. The technology base needed would provide a unifying framework to bring together what is now being done on an uncoordinated basis. This technology base would contain the elements - generic understanding, measurement techniques, and reference standards - that are needed to maintain our existing industry, but which are vital for the orderly growth of the emerging advanced ceramics.

This brings me to my second message. The development of this supporting technology base fits clearly with the legislated mission of the National Bureau of Standards. In advanced ceramics this infratechnology base is critical to our rapidly expanding industry, especially with the intense foreign competition that we are experiencing. For example, the vertical group organization of the Japanese ceramics industry provides a cooperation between ceramic powder supplier and component processor that is a key to rapid commercialization of this technology. This relationship in the U.S. industry, with a few exceptions, must come from an infratechnology base that provides measurement methods for ceramic structures and properties, generic materials property data (such as evaluated phase diagrams), and well-characterized reference materials. This fits the Bureau's mission; such broad technology base is not provided by the mission-oriented ceramics programs of the Department of Energy, NASA or the Department of Defense. Indeed, these agencies turn to NBS to provide these elements for their own programs.

To accomplish this mission, the Center for Materials Science at NBS already has in place a number of world-class activities and facilities upon which this program can build. These include a variety of measurement capabilities for characterizing ceramic structures and properties. They play a central role in the Evaluated Phase Diagram program I mentioned earlier; and indeed have been providing this particular kind of information for the traditional ceramics industry for about thirty-five years. They have a proven track record in providing the successful technology transfer that is needed by industry through symposia, workshops, and publications. Of particular importance in this regard are their Research Associate and Guest Worker programs; this open, unrestricted access to NBS is particularly appealing to industry.

In closing, I would like to re-emphasize my two messages by noting that the commercialization of advanced ceramics is in the exciting early stages of a very rapid growth and expansion. It is imperative for the Center for Materials Science at NBS to be involved and to take a greater role in this growth, so that the technology we need will be in place when we need it. Reprogramming of their present ceramics activities will not do the trick, as this work is already committed to supporting our traditional $30 billion ceramics industry in specific ways.

Thank you; I will be happy to answer any questions you may have.

BIOGRAPHICAL SUMMARY

William R. Prindle
Director, Administrative & Technical Services
Research & Development Division
Corning Glass Works
Corning, New York 14831
Tel: (607) 974-3331

EDUCATION:

B.S.	University of California at Berkeley (Physical Metallurgy)	1948
M.S.	University of California at Berkeley (Physical Metallurgy)	1950
Sc.D.	Massachusetts Institute of Technology (Ceramics)	1955

EXPERIENCE:

Director, Administrative & Technical Services - Corning Glass Works	1981-
Executive Director, National Materials Advisory Board	1976-1980
Vice President - R&D, Opt. Prod. Div., American Optical Corp.	1975-1976
Vice President - Research, American Optical Corporation	1971-1975
Member, Board of Directors - American Optical Corporation	1972-1976
Vice President - Research - Ferro Corporation	1967-1971
Director of Research - Ferro Corporation	1966-1967
Manager of Materials Research - American Optical Company	1962-1965
General Manager, R&D, Hazel-Atlas Division - Continental Can Co.	1959-1962
Manager of Research, Hazel-Atlas Division - Continental Can Co.	1957-1959
Assistant Technical Director - Hazel-Atlas Company	1954-1956
Project Supervisor, Div. of Industrial Coop. - MIT	1951-1954
Project Supervisor, Inst. of Eng. Research - Univ. of California (Berkeley)	1948-1950

PROFESSIONAL ACTIVITIES:

American Ceramic Society	1951-
Chairman, Glass Division	1966
Fellow	1967
Trustee	1968-1971
Treasurer	1971
Vice President	1972
President	1980
American Society for Testing & Materials	
Committee C-14 (Glass & Glass Products)	1955-
Society of Glass Technology	1951-
International Glass Commission	
Council, Executive Committee	1967-1970
President, XII International Congress on Glass, Albuquerque	1980
U.S. Representative, Steering Committee	1983-
Vice President	1984-

PROFESSIONAL ACTIVITIES, Cont'd.

Industrial Research Institute, Company Representative or Alternate	1966-1976 1981-
Federal Science and Technology Committee	1983-
Co-chairman, IRI/National Laboratories Task Force	1984-
National Academy of Sciences, National Research Council	
Evaluation Panel, Inorganic Materials Div., Nat'l. Bureau of Standards, Chairman	1970-1975 1975-1976
National Materials Advisory Board, Member	1973-1976
American Association for the Advancement of Science	1971-
American Society for Metals	1976-
Advisory Technical Awareness Council	1977-1980
Diamond Decade Committee	1979-1981
AIME	1977-
Visiting Committee, Dept. of Materials Science & Eng. - MIT	1979-
External Advisory Group, Dept. of Materials Science & Eng.-UCLA	1979-1982
Visiting Committee, Dept. of Metallurgy & Materials Science - Case Western Reserve University	1980
Board of Visitors, College of Engineering - Univ. of Pittsburgh	1980-1983
Visiting Committee, Dept. of Metallurgy & Materials Engineering-Univ. of Pittsburgh	1983-
Visiting Committee, Dept. of Materials Science & Eng. - Lehigh University	1981-
Outstanding Ceramist of New England (Award by New England Section, American Ceramic Society)	1974
MIT Ceramics Division Alumni Award	1980
John F. McMahon Engineering Lecture, Ceramic Association of New York and Western New York Section, American Ceramic Society	1983
Phoenix Award, Glass Industry Man of the Year	1983
Distinguished Visitor, New York State College of Ceramics, Alfred University	1984
Society of the Sigma Xi	
Keramos	

EXPERTISE:

Administration of research & development
Materials process development
Properties of materials and their relation to structure

PERSONAL DATA:

Born - December 19, 1926, San Francisco, California
Married, two children
Military experience: US Navy 1944-1946
Home Address: 27 Timber Lane, Painted Post, NY 14870
Home Telephone: (607) 962-2075

January 1985

Mr. WALGREN. Thank you very much, Dr. Prindle. We certainly appreciate that review.

The Chair would recognize the gentleman from New York, Mr. Lundine, at this point for a statement.

Mr. LUNDINE. Thank you, Mr. Chairman.

I want to welcome Dr. Prindle. I apologize for being late, but I had to be over on the Senate side, and you know those Senators talk on and on. Never does a Representative talk too long, but sometimes Senators do. I'm not going to fall into that trap.

But as I think the subcommittee has had an opportunity to see and hear Dr. Prindle, who's director of administrative and technical services for the Research and Development Division of Corning Glass Works and has been president of the American Ceramics Society, is one of the great experts in this important and vital field of advanced ceramics. To be competitive in this growing area, I think the United States has to solve technical problems associated with commercialization, and the National Bureau of Standards, in my view, needs to be a part of that.

Welcome, and it's nice to see you on my turf. I often see you on your own at the research facility for Corning Glass, and it's very nice to have you here.

Thank you very much, Mr. Chairman.

Mr. WALGREN. Thank you, Mr. Lundine.

Mr. LUNDINE. Can I ask unanimous consent that my welcome be placed at the appropriate place in the record?

Mr. WALGREN. In the record. Sure.

Mr. LUNDINE. You see, that's what revising and extending does for you.

Mr. WALGREN. Then let me also recognize the gentleman from Pennsylvania, Mr. Ritter.

Mr. RITTER. Thank you, Mr. Chairman.

It's with great pleasure that I introduce my constituent, Dr. Jim Leonard, from Bethlehem, PA. He's with Bethlehem Steel Corp., and is, I think, a man for the times. He has come from outside of the steel industry with a knowledge of manufacturing, of machinery, of tools, and with skills to apply this past knowledge to get the kind of job done that needs to be done in America's steel industry. And Jim is on the forefront of putting together new approaches to advancing our steel technology, not only dealing with what the past has shown others have done, but in—in an attempt to apply new science and new technology to steelmaking and steel production processes. I think he's—he's really leading the way in the industry. He's the chairman of the AISI's Committee on Technology and, I think, is a very worthwhile witness for these kinds of hearings on NBS and beyond.

Thank you, Mr. Chairman. And welcome Jim Leonard.

Mr. WALGREN. Thank you very much, Mr. Ritter.

Dr. Leonard, welcome to the committee. Please proceed.

Dr. LEONARD. Thank you, Mr. Chairman. And Congressman Ritter, thank you for those good words.

I am appearing here today on behalf of the American Iron & Steel Institute as relatively new chairman of the reorganized committee on technology of that institute. And I am here to speak in support of the National Bureau of Standards' fiscal 1986 budget, and particular in support of three specific ongoing or proposed activities of NBS which are mutual with our industry. The first of these is the reference materials program, the second is the sensor development program, and the third is the proposed joint collaborative research program involving the Federal National Laboratories, NBS and the steel industry, which has been loosely and collectively called the Keyworth initiative. I'd like to speak very briefly to each of those.

The steel industry strongly supports the continued development of what are called certified reference materials [CRM], which is being done by the Bureau of Standards. Our industry and the metals industry overall lean very heavily on NBS to process and certify materials to provide the accurate calibration of analytical techniques, both chemical and instrumental. Reliable, consistent certified reference materials help immeasurably to assure that steel and other such materials—including iron, ferro-alloys and ores—meet the compositional requirements of our customers. The use of these so-called CRM's to accurately calibrate analytical techniques provides the basis for agreement between producers and consumers regarding the composition of products. And I consider that to be a very appropriate governmental function.

Industry directly supports NBS in this reference materials program. In the mid-1970's, NBS was threatened with budget cuts which, in turn, would have reduced its output of CRM's, or reference materials, for the industry. Three committees of the American Society of Testing Materials [ASTM], involving analysis of metals and ores, formed a special committee to work with NBS to meet the needs for these CRM's at that time. Forty companies, including Bethlehem, pledged $182,000 at that time. The objective of this committee was to cooperate with NBS in defining CRM needs for the metal industry and helping NBS meet those needs. Bethlehem has further supported this joint effort by providing a technical consultant for this work whenever needed.

The joint program included defining industry needs for standards, prioritizing their development and providing manpower for use at and by NBS. One full-time and one part-time employee are paid by ASTM funds obtained from industry. The objective is to increase the supply of new CRM's on a timely basis. As of 1984, a total of 159 new or renewal CRM's, [certified reference materials], have been developed under this program, and are currently available and used by industry. Work is underway on about 50 more of these CRM's, and priorities have been established for the development of 20 more. That's clearly a successful cooperative program.

In the final analysis, CRM's are vitally needed to provide accurate analyses, which are absolutely essential to assure process control and to verify product composition. If we are to compete internationally and work efficiently domestically in our basic industries, we must have certified reference materials of the highest integrity. NBS meets this need now, and we know of no satisfactory alternative.

If I can move on now to the second program, the sensor development program. Several years ago, the American Iron & Steel Institute identified process control sensors as critical elements urgently needed to improve productivity and quality within the steel industry. The Bureau of Standards was also involved in providing a wide range of expertise and facilities aimed at helping develop selected high-priority sensors. The cooperative program that evolved was an excellent example of how a partnership between government and industry can be directed to meet the needs of both and our citizenship as a whole. NBS is charged with the goal of developing innovative advanced technology sensors and measurement systems, and the steel industry now has the goal of applying these high technology developments to regain its internationally competitive strength. That certainly is a good marriage.

In mid-1983, with the support of Dr. Robert Mehrabian, then Director of the Center of Materials Science at NBS, a 3-year agreement was put into place in which steel industry researchers joined NBS scientists in programs to develop two high-priority sensors—specifically, those for the measurement of internal temperature in materials and what is called pipe or porosity in the solidified metal.

There were many good reasons for initiating this joint research program, and they remain valid today. As you know—or I hope you know—sensor research and development requires a broad range of expertise in diverse fields such as lasers, ultrasonics, high temperature physics, electronics and optics. NBS has world class theoretical and experimental expertise and facilities in these high tech fields, and here it is being brought to bear on helping a struggling basic industry regain its competitiveness and technical leadership.

One measurement of the success of this joint research program is the effectiveness with which the new technology is transferred from NBS and laboratories to the industry, including implementation in steel production plants. To facilitate this process, up to five steel industry research associates have been working on site at NBS, and at least one of them is present in this room today. They provide technical expertise, as well as working knowledge of the steel plant environment, and serve as the conduit to carry this new high technology developments back to the participating industries.

Recent AISI researchers have been from Bethlehem Steel, LTV Steel, and United States Steel. Participants in the program have remained enthusiastic in their quest for successful implementation of the sensors, even though budgetary constraints have occurred on the part of both the government and the steel industry. We plan to continue our work at NBS aimed at providing the science base of sensors which are needed to improve steel industry productivity and quality, and that's competitiveness.

Turning now to the third program, the so-called Keyworth initiative, this proposal stems initially from the May 1983 report of the White House Science Council's Federal Laboratory Review Panel, known as the Packard report, which strongly recommended increasing the collaboration of the Federal laboratories with universities and industry in general.

Subsequently, Dr. George Keyworth, science advisor to the President, and Mr. Howard M. Love, chairman of national intergroup, as members of the Presidential committee on industrial competitiveness, identified the possibility that this recommendation could be related to the long-range problems of the domestic steel industry.

In February of last year, members of the American Iron & Steel Institute Committee on General Research joined Mr. Love and Dr. Keyworth for a meeting in the White House and, shortly thereafter, joint exploratory studies between certain national laboratories and steel industry scientists were commenced spontaneously.

During the latter half of 1984, four joint task groups made an intensive and well documented search for new approaches in steelmaking, in casting of metals, in product development, and process control engineering. Those were the four major fields. As a result of these studies, opportunities for long-range and innovate technological development were identified in two major areas: One was determined to be direct production of liquid steel from iron ore, which would bypass the traditional coke ovens and blast furnaces; and the second was casting of near net shape solids, so-called, using electromagnetic containment, which is the strength of the National Laboratories. Those two areas put together and, if implemented, would indeed represent breakthrough technology, new low-cost high technology means of making the basic commodity we know as steel.

The lead National Laboratory for these projects, as it is currently envisioned, is Argonne, which has extensive capabilities in development and application of a variety of related technologies, including magnetohydrodynamics, metallurgy, slag-refractory interactions and complex chemical and electro-mechanical systems. Oak Ridge will play a major role in the thermo-mechanical aspects of these projects, especially in microstructure evaluation. And last, but not least, the National Bureau of Standards will participate in the area of advanced sensor development as an extension of the sensor development program we mentioned earlier.

By September of last year, the proposed research program had been developed to the point that funding needs could be identified. And I have introduced into the record a joint Argonne AISI report which presents the detailed work plans which were developed at that time.

A total of $14 million per year for 1985 and 1986 was suggested and is broken down as follows: $10 million from the Department of Energy through the National Laboratories, $2½ million a year from the Department of Commerce via the National Bureau of Standards, and $1½ million a year from the steel industry itself through what is known as AISI. This AISI industry funding would support 15 industry scientists who will work side by side with government scientists at the National Laboratories and at the Bureau of Standards. The importance of this close working relationship just can't be overestimated and can't be overemphasized. This would serve as a prototype for future joint industry hands-on collaborative efforts in what I like to think of as an alliance for restoring our competitiveness.

Last November, the AISI board of directors approved participation at the funding level I just mentioned for the 2 years, with half of the funds to come from the basic AISI institute budget—at the expense of other programs, by the way—and half from the individual participating companies. I'm pleased to say to you that that support has been recently reaffirmed by the board of directors of our institute.

The proposed research program was submitted by the Office of Science and Technology Policy to the Office of Management and Budget for approval in December with the strong endorsement of OSTP, Argonne, NBS and, of course, the American Iron and Steel Institute.

Unfortunately, because of budget reduction efforts at OMB, no funds were included for DOE or for the Department of Commerce for this program either for 1985 or 1986. Tomorrow, I will also testify before the Subcommittee on Energy Development and Applications of the Science and Technology Committee. In both instances, I want to convey as emphatically as I can that these programs are essential, both in the steel industry and at the National Labs and the Bureau of Standards. I am hopeful that funding of this program will be forthcoming, and a key component of this is the extension of the already clearly successful NBS sensor program.

In conclusion, the steel industry enthusiastically supports continued close collaboration with the Bureau of Standards, both in the longstanding reference materials program and in the newer sensor development program. In particular, we are hopeful that the latter program will develop into part of a broader steel industry/Government/university leapfrog technology collaboration which will serve as a model for future technology alliances between Government, industry, and universities aimed at regaining and maintaining our technology lead in key races we clearly face internationally.

These programs I recommended are vital if we Americans in basic industries are to rejuvenate our industries enough to compete internationally in arenas such as steel, where other nations are gaining technological capability very rapidly in almost all cases based on extensive aid and support of their governments. We, who have been technology leaders in the past, can and must do better now if we are to rejuvenate our essential basic industries. And here in these modest NBS programs is a fine example of an alliance for the benefit of our Nation's international competitiveness.

Thank you, Mr. Chairman and members of the committee.

[The prepared statement of Dr. Leonard follows:]

Statement by James H. Leonard, Vice President, Technology, Bethlehem Steel Corporation, Before House of Representatives' Subcommittee on Science, Research and Technology, March 6, 1985

My name is James H. Leonard, Vice President for Technology, Bethlehem Steel Corporation. I am also Chairman of the American Iron and Steel Institute Committee on Technology. I am appearing today on behalf of AISI and Bethlehem Steel. AISI is the principal trade association of the domestic iron and steel industry whose 56 member companies account for approximately 90% of the nation's steel production capability. Bethlehem Steel Corporation is a large American steel producer with an annual steel production capability of 17.6 million tons.

It is a pleasure to appear before this Subcommittee in support of the National Bureau of Standards 1986 fiscal year budget. The steel industry has had a close working relationship with the Bureau dating back to 1906. Over the years the industry and the Bureau have been mutually supportive in a variety of endeavors. Today I would like to talk about three ongoing or proposed mutual activities. First is the reference materials program; the second, the sensor development program; and the third, the proposed joint collaborative research program involving the National Laboratories, NBS and the steel industry -- the so-called Keyworth Initiative.

Reference Materials Program

The steel industry strongly support the continued development of Certified Reference Materials (CRMs) by the National Bureau of Standards (NBS). Our industry, and the metals industry overall, lean heavily on NBS to process and certify materials to provide accurate calibration of analytical techniques, both chemical and instrumental. Reliable, consistent Certified Reference Materials help immeasurably to assure that steel and associated materials such as iron, ferro-alloys, and ores, meet the compositional requirements of our customers. The use of CRMs to accurately calibrate analytical techniques provides the basis for agreement between producers and consumers regarding the composition of products.

The steel industry first approached NBS in 1906 to make and certify a CRM for grey cast iron. The industry at that time needed a CRM of proven uniformity whose composition could be defined by the best analytical methods available. It needed a CRM supported by an organization of the highest integrity. Time has proven that to be a wise decision. CRMs made by NBS are now accepted worldwide. Its certification techniques are readily accepted by other national certification agencies and NBS reference materials are usually preferred over those developed by other countries.

As Bethlehem's T. R. Linde stated in the February 1985 issue of American Society for Testing and Materials Standardization News, NBS Certified Reference Materials are extremely valuable due to the integrity of NBS as the certification agency, their acceptance worldwide by both producers and consumers, the extensive effort made through consensus analysis in many laboratories to characterize their chemical composition, and their limited supply. CRMs are as precious as gold in some instances. A copy of Linde's article is attached.

The development and certification of CRMs is a two-way street. Industry and NBS work together closely to meet the needs. The steel industry contributes by specifying its needs, providing technical assistance in making specific grades of steel, fabricating them to the desired shape and supplying chemical analyses for certification. NBS coordinates all efforts, investigates the homogeneity of the candidate material, processes acceptable material to final form, provides supporting analyses, verifies that analyses from cooperating laboratories are performed properly, certifies the composition and, finally, packages and sells the CRM.

Since the 1920s, and perhaps even earlier, Bethlehem has worked closely with NBS to develop needed CRMs. In the last 15 years, we have made and fabricated material for 5 steel standards and two ores, one iron and one titanium. We and other steel company representatives have met extensively with NBS to help decide what is required to meet future steel industry needs, and to guide NBS in setting up the best metallurgical and fabricating processes to guarantee the specific composition and homogeneity of CRMs. Our strongest support of NBS programs has been to provide careful, time-consuming reference chemical analyses to certify composition. Bethlehem helps certify on the average of 2 CRMs/year using at least 2 of Bethlehem's Laboratories including the facilities at our Homer Research Labs. For each CRM in each laboratory about one man-month effort is expended without charge to NBS.

Industry supports NBS in another way. In the mid-70s, NBS was threatened with budget cuts, which in turn would have reduced its output of CRMs for the metals industry. Three committees of ASTM, involving analysis of metals and ores, formed a special committee to work with NBS to meet the needs for CRMs in this area. Forty companies, including Bethlehem, pledged $182,000. The objective of this committee was to cooperate with NBS in defining CRM needs of the metal industry and helping NBS meet those needs. We have further supported this joint NBS/ASTM effort by providing a technical consultant for this work whenever needed. The joint program includes defining industry needs for standards, prioritizing their development and providing manpower for use at and by NBS. One full-time and one part-time employee are paid for by ASTM funds obtained from industry. The objective is to increase the supply of needed CRMs on a timely basis. As of 1984, a total of 159 new or renewal CRMs have been developed by this program and are currently available to industry. Work is underway on about 50 more CRMs, and priorities have been established for the development of 20 more.

As an example of the critical importance of CRMs, several years ago steel pipe for the Alaskan pipeline had to be made with 0.005% or less sulfur. This was a new specification for which improved steelmaking technology was required. The Japanese led us in this area, and were making steel that met specifications. We had difficulty, which was traced to lack of adequate CRMs. In the final analysis the problem was not so much in making steel to fit the sulfur specification as it was the lack of a reliable CRM to prove conclusively that the desired level of sulfur had been attained. Another problem currently plaguing the industry is the accurate determination of hydrogen in steel at levels of 0.1 to 5 parts per million. Hydrogen causes internal defects in steel forgings, plates and rails that cannot be tolerated or easily repaired. No nationally certified standards exist, and the technology to provide homogenous CRMs is not well understood. We hope that NBS will soon develop the methodology, and the the CRMs.

In the final analysis, CRMs are vitally needed to provide accurate analyses, which are absolutely essential to assure process control and to verify that product composition meets customer specifications. If we are to compete internationally and work efficiently domestically, we must have Certified Reference Materials of the highest integrity. NBS meets this need now, and we know of no satisfactory alternative.

Sensor Development Program

Several years ago the American Iron and Steel Institute identified process control sensors as critical elements needed to improve productivity and quality within the steel industry. The Department of Commerce, through the National Bureau of Standards, was also involved in providing a wide range of expertise and facilities aimed at helping develop selected high priority sensor needs. The cooperative program that developed is an excellent example of how a partnership between government and industry can be directed to meet the needs of both. NBS is charged with the goal of developing innovative sensors and measurement technology, and the steel industry has the goal of applying the technology to improve its processes.

In 1980, the General Research Committee of AISI began a program to define specific process control sensor needs which, if met, would have a substantial impact on improving productivity and quality in the steel industry. A large number of process control sensor needs were pinpointed, of which 18 were considered most significant and in need of substantial technical development before they could be commercialized. Manufacturers of commercial equipment were not aggressive in developing the sensors because of the high-risk and perceived limited market size.

In 1982, NBS became involved in this effort with AISI. A workshop was held at the National Bureau of Standards in Gaithersburg, jointly sponsored by AISI, the Defense Advanced Research Projects Agency and the Bureau. From the 18 sensors already defined, four high priority sensor needs were selected as a way to focus limited resources. These sensor needs included: Rapid Measurement of Temperature Distribution Within a Solid or Solidifying Body of Hot Steel (i.e., measuring internal temperature without penetrating the material); Automatic Detection of Pipe and Gross Porosity in Hot Steel Billets, Blooms or Slabs (i.e., assuring the absence of voids inside the hot steel before it is processed into finished product); Rapid In-Process Analysis of Molten Metal (i.e., measuring the chemical composition of the molten metal so that it can be rapidly adjusted to specifications through controlled alloy additions); and On-Line Inspection of Surface Defects on Hot and Cold Strip (i.e., identifying and classifying surface imperfections in sheet steels while they are moving at speeds to 6,000 feet per minute).

By mid-1983, with the support of Dr. Robert Mehrabian, then Director of the Center of Materials Science at NBS, a three-year agreement was put into place in which steel industry researchers joined NBS scientists in programs to develop two of the four high-priority sensors -- specifically, the Internal Temperature and Pipe/Porosity sensors. As the work at NBS got underway, AISI worked with other government and private organizations to address the other two needs. Significant technical work on them is underway at the Department of Energy laboratories including:

Battelle/PNL - sensors for internal temperature, particularly for cast product; Los Alamos - sensors for molten metal analysis; and AISI-sponsored sensor development at several private and academic organizations. We feel that these cooperative programs have been successful in bringing together technical resources and the applications expertise needed for practical scientific developments.

There were many good reasons for initiating the AISI/NBS joint research program, and they remain valid today. Four important ones include expertise, facilities, organization and technology transfer. As you know, sensor research and development requires a broad range of expertise in diverse fields such as ultrasonics, high temperature physics, electronics and optics. NBS has world-class theoretical and experimental expertise in these fields and it has been brought to bear on the difficult temperature and porosity sensor problems. Experimental equipment and support facilities are also available at NBS to evaluate new sensor concepts and to test the prototype sensor designs. These include high-intensity laser/ultrasonic drivers and electromagnetic acoustic receivers that are unavailable in the steel industry research laboratories. The cooperative efforts on the part of the participating partners extend available government resources as far as practical. A recent example involves work to evaluate an experimental ultrasonic sensor that requires large hot steel test samples and, therefore, a large furnace to heat them. An appropriate furnace was unavailable at NBS, but was available through cooperation with Argonne National Laboratory. A portion of the work was shifted to Argonne to take advantage of their facilities. Proceeding on this basis avoids spending scarce funds on duplicate facilities.

Several organizational aspects of the joint AISI/NBS program are conducive to the success of the sensor development program. The work fits nicely into the Materials Characterization Group located within the Metallurgy Division of the Center of Materials Science. Project management techniques and scheduled reviews with the NBS staff and AISI participants have proven effective in keeping the program on course. Also there is ready access to expertise and support from other areas of NBS, coordinated through the Office for Nondestructive Evaluation.

One measure of the success of these joint research programs is the effectiveness by which technology is transferred from the laboratory to the industry, including implementation in the steel plants. To facilitate this process, up to five steel industry Research Associates have been working on-site at NBS. They provide technical expertise as well as a working knowledge of the steel plant environment and serve as a conduit to carry sensor technology back to the participating companies. Recent AISI researchers have been from Bethlehem Steel, LTV and U.S. Steel. As noted last month by Dr. Lyle Schwartz, Director of the NBS Center of Materials Science, "This will help to ensure acceptance of the research results and assist in the successful transfer of the technology to the users."

Participants in the program have remained enthusiastic in their quest for successful implementation of the sensors, even though budgetary constraints have occurred on the part of both the government and the steel industry. We plan to continue our work at NBS aimed at provided the science base for sensors needed to improve steel industry productivity and quality.

Collaborative Research on "Leapfrog Technology"

The May 1983 report of the White House Science Council's Federal Laboratory Review Panel, known as the "Packard Report," strongly recommended increasing the collaboration of the federal laboratories with universities and industry. Subsequently, Dr. G. A. Keyworth, Science Advisor to the President, and Howard M. Love, Chairman of National Intergroup, as members of the Presidential Committee on Industrial Competitiveness (PCIC), identified the possibility that this recommendation could be related to the long-range problems of the domestic steel industry. In a February 3, 1984, presentation to the PCIC, Mr. Love made the following suggestion:

> What I am proposing, then, is that steel firms come together to identify an agenda for R&D on leapfrog technologies, and then join with the National Labs to realize that agenda. Let me stress that this must be R&D on leapfrog technologies. If we fall into the rut of 'business and usual,' and merely agree on a modest agenda on R&D for incremental improvements, we will have failed. Let's envision a steel industry where we throw away the blast furnaces, throw away coke ovens, and develop entirely new ways of making a higher quality, higher yield product, at smaller scales, with greater flexibility and more automation.
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> Let me also stress that by seeking a technological solution, we are building upon our national strengths. We can't compete with the third world on the cost of labor or capital. The one thing we have in our favor is the best science and technology base in the world. Let's take advantage of the base; let's utilize it for the benefit of our basic industries.

On February 8, 1984, members of the Committee on General Research joined Mr. Love and Dr. Keyworth for a meeting in the White House; and, shortly thereafter, joint exploratory studies between certain National Laboratories and steel industry scientists were underway. The nature of this joint effort was reviewed by Dr. Keyworth in his speech at the AISI General Meeting on May 24, 1984.

During the latter half of 1984, four joint task groups under the direction of a Joint Steering Committee made an intensive and well documented search for new approaches in steelmaking, casting, product development and control engineering. The enthusiasm of the steel industry participants in these long-range analyses has been sustained by rapid, high-quality responses from the scientists at the Argonne and Oak Ridge

National Laboratories and the National Bureau of Standards. There has also been all-around recognition that the steel industry is limited in its ability to commit its severely limited resources to long-term objectives. As a result of these studies, opportunities for long range and novel technological development were identified in two areas:

A. Direct Production of Liquid Steel from Iron Ore

The first objective is to develop for the mid-term (commercialization within about 15 years) an optimized process for the direct carbo-thermal reduction of iron ore to steel. The process sought would leapfrog existing technology by replacing the conventional coke oven and blast furnace and possibly also the subsequent steelmaking step. Coal is the preferred reductant in the process because of its inherent cost advantage over other fuels, and the process evaluation and development will emphasize the utilization of a wide range of domestic coals and iron ores as feedstocks. The ideal target process will result in a 50% reduction in capital costs and a 30% reduction in operating and maintenance costs as compared with present technology.

B. Casting of Near Net Shape Solids

Because molds intrinsically have the potential to produce defects in cast metal, the main objective of this task will be to develop "mold-less" processes, especially for steel strip. The most promising approach will adapt electromagnetic containment currently in use for casting of aluminum. Further objectives are to (1) investigate methods for removal of nonmetallic inclusions to facilitate near-net-shape casting and (2) develop the solidification models, sensors, and the thermomechanical processing steps required to produce the requisite finished properties from the near-net-shape cast structure. This "model process" would achieve a superior product with minimal capital equipment, energy, and operating costs.

The lead National Laboratory for these projects, as currently envisioned, would be Argonne, which has extensive capabilities in development and application of a variety of related technologies, including magnetohydrodynamics, metallurgy, slag-refractory interactions and complex chemical and electromechanical systems. Oak Ridge would play a major role in the thermo-mechanical aspects of these projects, especially in microstructure evaluation. The National Bureau of Standards would participate in the area of advanced sensor development, as an extension of the sensor development program described earlier.

By October of 1984 the proposed research program had been developed to the point that funding needs could be identified (see attached "Federal Laboratory-Steel Industry Initiative: Summary and Work Plans" dated September 1984). A total of $14 million/year for 1985 and 1986 was suggested, broken down as follows: $10 million/year from the Department of Energy (National Laboratories), $2.5 million/year from the Department of Commerce (National Bureau of Standards) and $1.5 million/year from the steel industry (AISI). The AISI funding would support 15 industry scientists who would work side-by-side with government scientists at the National Laboratories and at the Bureau of Standards. The importance of this close working relationship cannot be overemphasized. It could serve as a prototype for future joint government-industry "hands-on" collaborative efforts. In November the AISI Board of Directors approved participation at this funding level for two years, with half the funds to come from the AISI budget and half from the individual participating companies.

In December Argonne National Laboratory had identified twelve scientists to work on their portion of the first year's work. Enthusiasm on the part of the government and industry scientists was high. The proposed research program was submitted by the Office of Science and Technology Policy to the Office of Management and Budget for approval in December with the strong endorsement of Argonne, NBS and AISI.

Unfortunately, because of budget reduction efforts at OMB, no funds were included for DOE or DOC for this program either for 1985 (supplemental) or 1986. In order for this program to stay alive we are advised that Congress will have to approve funding as a specific additional or reallocated item in the 1986 budget. We have been told that NBS will continue steel industry support at current levels, i.e., about $1 million/year, primarily for this research program, even if no additional funding is provided in the 1986 budget. Thus the key appears to be getting DOE funding for the program. This morning I testified before the Subcommittee on Energy Development and Applications of the Science and Technology Committee. I emphasized the broad-based support that this program has both in the steel industry and at the National Laboratories and the Bureau of Standards. I am hopeful that funding for the program will be forthcoming.

In conclusion, the steel industry and Bethlehem enthusiastically support continued close collaboration with the Bureau of Standards, both in the long-standing reference materials program and in the newer sensor development program. In particular, we are hopeful that the latter program will develop into part of a broader, steel industry-government "leapfrog technology" collaboration which will serve as a model for the future.

Statement by James H. Leonard, Vice President, Technology, Bethlehem Steel Corporation, Before House of Representatives' Subcommittee on Energy Development and Applications, March 6, 1985

My name is James H. Leonard, Vice President for Technology, Bethlehem Steel Corporation. I am also Chairman of the American Iron and Steel Institute Committee on Technology. I am appearing today on behalf of AISI and Bethlehem Steel. AISI is the principal trade association of the domestic iron and steel industry whose 56 member companies account for approximately 90% of the nation's steel production capability. Bethlehem Steel Corporation is a large American steel producer with an annual steel production capability of 17.6 million tons.

It is a pleasure to appear before this Subcommittee on the subject of the FY 1986 budget for the Industrial Programs portion of the Conservation and Renewable Energy program of DOE. As part of this program, my company, in partnership with U.S. Steel, entered into a cooperative agreement with DOE last September to develop a new technology to produce sheet steels with a major energy savings (approximately 0.2 QUAD/year by 1990) and with a significant capital and operating cost savings ($35/ton and $45/ton, respectively) over existing steel slab casting technology. The total estimated cost of the five year development program is $32.9 million with U.S. Steel and Bethlehem cost sharing up to $4.1 million. The approach is to cast thin steel sections one-half to one inch in thickness using moving-mold casters, followed by hot rolling to about 0.1 inch in thickness. The resulting steel hot band could be commercially applied directly or subsequently cold rolled and heat treated for other commercial applications. The federal funding for this program will be repaid from the use and sale of the technology developed. The FY 1986 budget of the Industrial Programs Office contains funding for continuation of this development program, which we obviously endorse.

We would also like to call to the attention of this Subcommittee for its consideration another program which would most appropriately fall within DOE's conservation and renewable energy program. This proposed joint collaborative research program involving the National Laboratories, the

National Bureau of Standards and the steel industry - the so-called Keyworth Initiative - has been recommended by the Office of Science and Technology Policy for inclusion in the FY 1986 budget. I would like to give you some background on this proposal and its current status.

The May 1983 report of the White House Science Council's Federal Laboratory Review Panel, known as the "Packard Report," strongly recommended increasing the collaboration of the federal laboratories with universities and industry. Subsequently, Dr. G. A. Keyworth, Science Advisor to the President, and Howard M. Love, Chairman of National Intergroup, as members of the Presidential Committee on Industrial Competitiveness (PCIC), identified the possibility that this recommendation could be related to the long-range problems of the domestic steel industry. In a February 3, 1984, presentation to the PCIC, Mr. Love made the following suggestion:

> What I am proposing, then, is that steel firms come together to identify an agenda for R&D on leapfrog technologies, and then join with the National Labs to realize that agenda. Let me stress that this must be R&D on leapfrog technologies. If we fall into the rut of 'business and usual,' and merely agree on a modest agenda on R&D for incremental improvements, we will have failed. Let's envision a steel industry where we throw away the blast furnaces, throw away coke ovens, and develop entirely new ways of making a higher quality, higher yield product, at smaller scales, with greater flexibility and more automation.
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> Let me also stress that by seeking a technological solution, we are building upon our national strengths. We can't compete with the third world on the cost of labor or capital. The one thing we have in our favor is the best science and technology base in the world. Let's take advantage of the base; let's utilize it for the benefit of our basic industries.

On February 8, 1984, members of the Committee on General Research joined Mr. Love and Dr. Keyworth for a meeting in the White House; and, shortly thereafter, joint exploratory studies between certain National Laboratories and steel industry scientists were underway. The nature of this joint effort was reviewed by Dr. Keyworth in his speech at the AISI General Meeting on May 24, 1984.

During the latter half of 1984, four joint task groups under the direction of a Joint Steering Committee made an intensive and well documented search for new approaches in steelmaking, casting, product development, and control engineering. The enthusiasm of the steel industry participants in these long-range analyses has been sustained by rapid, high-quality responses from the scientists at the Argonne and Oak Ridge National Laboratories and the National Bureau of Standards. There has also been all-around recognition that the steel industry is limited in its ability to commit its severely limited resources to long-term objectives. As a result of these studies, opportunities for long range and novel technological development were identified in two areas:

A. Direct Production of Liquid Steel from Iron Ore

The first objective is to develop for the mid-term (commercialization within about 15 years) an optimized process for the direct carbo-thermal reduction of iron ore to steel. The process sought would leapfrog existing technology by replacing the conventional coke oven and blast furnace and possibly also the subsequent steelmaking step. Coal is the preferred reductant in the process because of its inherent cost advantage over other fuels, and the process evaluation and development will emphasize the utilization of a wide range of domestic coals and iron ores as feedstocks. The ideal target process will result in a 50% reduction in capital costs and a 30% reduction in operating and maintenance costs as compared with present technology.

B. Casting of Near Net Shape Solids

> Because molds intrinsically have the potential to produce defects in cast metal, the main objective of this task will be to develop "mold-less" processes, especially for steel strip. The most promising approach will adapt electromagnetic containment currently in use for casting of aluminum. Further objectives are to (1) investigate methods for removal of nonmetallic inclusions to facilitate near-net-shape casting and (2) develop the solidification models, sensors, and the thermomechanical processing steps required to produce the requisite finished properties from the near-net-shape cast structure. This "model process" would achieve a superior product with minimal capital equipment, energy, and operating costs.

The lead National Laboratory for these projects, as currently envisioned, would be Argonne, which has extensive capabilities in development and application of a variety of related technologies, including magnetohydrodynamics, metallurgy, slag-refractory interactions and complex chemical and electromechanical systems. Oak Ridge would play a major role in the thermo-mechanical aspects of these projects, especially in microstructure evaluation. The National Bureau of Standards would participate in the area of advanced sensor development, as an extension of ongoing AISI/NBS sensor development work.

By October of 1984 the proposed research program had been developed to the point that funding needs could be identified (see attached "Federal Laboratory-Steel Industry Initiative: Summary and Work Plans" dated September 1984). A total of $14 million/year for 1985 and 1986 was suggested, broken down as follows: $10 million/year from the Department of Energy (National Laboratories), $2.5 million/year from the Department of Commerce (National Bureau of Standards) and $1.5 million/year from the steel industry (AISI). The AISI funding would support 15 industry scientists who would work side-by-side with government scientists at the National Laboratories and at the Bureau of Standards. The importance of this close working relationship cannot be overemphasized. It could serve as a prototype for future joint government-industry "hands-on" collaborative efforts. In November the AISI Board of Directors approved participation at this funding level for two years, with half the funds to come from the AISI budget and half from the individual participating companies.

In December Argonne National Laboratory had identified twelve scientists to work on their portion of the first year's work. Enthusiasm on the part of the government and industry scientists was high. The proposed research program was submitted by the Office of Science and Technology Policy to the Office of Management and Budget for approval in December with the strong endorsement of Argonne, NBS and AISI.

Unfortunately, because of budget reduction efforts at OMB, no funds were included for DOE or DOC for this program either for 1985 (supplemental) or 1986. In order for this program to stay alive we are advised that Congress will have to approve funding as a specific additional or reallocated item in the 1986 budget. We have been told that NBS will continue steel industry support at current levels, i.e., about $1 million/year, primarily for this research program, even if no additional funding is provided in the 1986 budget. We would ask that this Subcommittee consider authorizing DOE funding for this initiative in the FY 1986 budget. In so doing we want to emphasize that, as its popular title - the Keyworth Initiative - implies, the proposed research program received its main impetus through government sponsorship, obviously fully supported by the steel industry. With the strong encouragement of the Office of Science and Technology Policy, the National Laboratories, the Bureau of Standards and the steel industry are now all enthusiastic supporters of the program and a great deal of preliminary planning has been done. We believe the merits of this idea are self-evident and it could serve as a model for future industry-government collaborative efforts to improve the competitiveness of U.S. basic industries. This pioneering endeavor should not be allowed to die.

BIOGRAPHICAL DATA

Dr. James H. Leonard
Vice President, Technology
Bethlehem Steel Corporation

A native of Cincinnati, Ohio, Dr. Leonard received a bachelor of science degree from the University of Cincinnati and master of science and doctor of philosophy degrees from the University of Pittsburgh, all in chemical engineering.

After receiving his doctorate in 1960, he held supervisory and managerial positions with Westinghouse Electric Corporation as a scientist and engineer. In 1965 he was named director of the laboratory of nuclear research at the University of Cincinnati.

From 1969 to 1974 he was a professor and head of the university's department of chemical and nuclear engineering and chairman of the faculty advisory committee on research.

In 1974 he established an engineering and science consulting firm and in 1977 was named director of the advanced technology center for Allis-Chalmers Corporation. His most recent position with Allis-Chalmers was general manager of the hydroturbine division.

In August, 1983, Dr. Leonard was elected vice president, technology, for Bethlehem Steel. Reporting to Dr. Leonard are the corporate research and engineering departments and Bethlehem International Engineering Corporation, a wholly-owned subsidiary of Bethlehem Steel.

Dr. Leonard has been active with numerous professional associations, including the American Society of Engineering Education, American Nuclear Society and American Institute of Chemical Engineers.

Research projects for which he has received several patents have been sponsored by various federal agencies, including some commissioned by the U.S. Environmental Protection Agency. In addition, he has published many technical papers on nuclear power and reactors and is a recognized authority on energy matters.

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Mr. **Walgren**. We will come back for some further conversation, but let's turn to Dr. Berry, who, as I understand it, is steeped in chemistry. Welcome to the committee. We appreciate your being here.

Dr. **Berry**. Thank you very much, Mr. Chairman and members of the subcommittee.

Let me begin by saying I believe that the principal reason I'm here is in my role as Chairman of the Numerical Data Advisory Board of the National Research Council. But I do have some other familiarity with the problems of the Bureau. I'm currently Chairman of the National Research Council Review Panel for the Center for Basic Standards and, as a result, I'm fairly familiar with the issues that Dr. Seitz, Dr. Prindle, and Dr. Leonard have presented to you, and I can certainly second what they have said. I think the issues they've presented are supported and very deserving indeed.

I'll address myself to the issue of the scientific data that is the responsibility of the National Bureau of Standards. But I'd like to do that by putting it in a slightly larger context and go back to a set of steps in an argument that you'll find in my written testimony. I'd like to go through six steps in an argument. I once had a Congressman say to me that when one had to actually write a bill, it had to contain no more than two steps in an argument, but inside these boundaries, I guess we can talk about more complicated things.

Mr. **Walgren**. We make it a point not to chew gum while we take the six steps. [Laughter.]

Dr. **Berry**. The first point I'd like to make is that the Bureau of Standards, as you know, is one component in the Department of Commerce. Now the Department of Commerce itself is a very useful, helpful thing in our society, but the United States could get along, it could perhaps even thrive, without the Department of Commerce. But we could not get along with the kind of society in which we now live without the Bureau of Standards and some of the other technical nonpolitical components in the Department of Commerce. That is, we simply could not maintain the technological society that we live in without the services that are performed by the National Bureau of Standards.

The second point is that the National Bureau of Standards has a number of responsibilities, some of which my predecessors on this panel have referred to, that are unique to the Bureau and that are proper responsibilities of a governmental agency. That is they're the kinds of services which even my University of Chicago economist colleagues would say belong in government and not in private industry. That is, they provide goods that are so public, so diffused, that they could not be captured by private investors, and yet the society needs them to continue as we do.

Now among these are the maintenance of the basic standards that we used to call weights and measures, that is, standards units of mass, length, temperature, pressure, electrical units, time, frequency, the fundamental constants of nature. I did say something in my written testimony about the fundamental constance of nature, in particular, as an illustration of how the topic of basic data is often thought of as one of the world's dullest subjects. But, in fact, at its leading edge, is a very, very exciting and challenging part of science. That is, in some ways, the measurement of the last decimal place in the speed of light is very much a forefront issue in science because it pushes the basic laser science to its very outer edges and leads us to new developments.

Another example. There was a discovery made at the very end of the 1970's of a phenomenon called the quantized Hall effect. It's an effect that has to do with the generation of voltage when a current passes in a thin film in the presence of a magnetic field. It turns out that this voltage and the corresponding resistance, electrical resistance that goes with that voltage, come in quantized units. As a result, there is a means now of making a fundamental measurement of resistance, electrical resistance, in an absolute manner, that is in terms of the fundamental constants of nature.

Now this can be used in either of two ways. It could be used to help determine the fundamental constance of nature, or one can use the fundamental constance other ways to evaluate resistance and compare it with our traditional standard, which consisted of a spool of wire at the Bureau of Standards. Now, in fact, what one does is combine these to do a little of both and see how everything fits together.

The result of this was that people found and were very concerned that, up to about a year ago, there was something wrong, the data didn't fit. All of the measurements that had been made previously of resistance were over on one place and the new set based on this new phenomenon, were in a different place. This year, because of this basic new discovery, the people at the Bureau of Standards were able to find that this spool of wire, which they keep very carefully protected immersed in a tank of oil, was changing. Our basic standard of resistance was drifting. Now they caught it before there was any serious problem. But the result could have been that, in another years or so, if it hadn't been caught, our electrical standards would be off enough from those in other places in the world that we'd have difficulty with matching some of the the most finely tuned controls we have. For example, we'd probably have difficulty doing simultaneous television circuitry on several channels because of problems in matching the electrical circuitry. It was caught because we maintain these standards, because we're constantly checking for these fundamental constants. So I brought these in to illustrate the kind of ongoing basic metrology that we must have to keep our society going.

Now the other kinds of responsibilities that the Bureau has, and those I want to mention, are the maintenance of the flow of reliable data regarding physical substances and processes which Dr. Seitz, especially Dr. Prindle and Dr. Leonard, have already talked about. This includes sometimes the generation of data, development of the methods of measurement, the assessment of data, evaluation and compilation and the dissemination of data. All of these responsibilities are there and, in fact, are legally mandated to the Bureau. There is a law called the Standard Reference Data Act that specifically gives the Secretary of Commerce and, in the explanatory literature, the Bureau of Standards the charge for carrying out those responsibilities.

Third, of course, the Bureau is responsible for providing to industry the services necessary to maintain their own standards—that is, calibration services, working with industry to help develop standards, to help develop devices to maintain standards.

In 1981, just over 3 years ago, I spoke before your subcommittee and I gave a number of specific examples of how scientific data was crucial for the advancement of science and technology, and I gave a few examples where there were some serious problems because things hadn't worked due to unavailability of data.

I'm not going to give you any more examples specifically this time. The situation has changed. It's changed in the direction that, instead of specific examples, I've put into my written testimony a bibliography of workshop reports, conference reports, in which the users of scientific data have spelled out their own needs in situations which have arisen in which they have not had access to the data they felt they needed. That is, instead of a few examples that I can give you secondhand, now I'm turning to you and saying here are their stories, lots of them, many more than I'll try to present myself, and you can get them firsthand from this bibliography.

The users community has simply gotten more and more vocal about their needs because presumably their needs have gotten greater. Our inadequacies in supplying of data have gotten steadily worse and the situation has become one of great concern to the National Science Board, and to the American Chemical Society. I think you heard these gentlemen speaking of some of these issues themselves.

Now in this list, in fact, there are 19 separate reports. The oldest is from 1976, but almost all of them are from 1982, 1983 or 1984. The problem is growing, and I want very much to urge the committee to consider this as a serious and growing problem. That is the third point that I want to make, that the scientific community, the technological community, the engineering community, are all very concerned themselves. One can see this among the leaders in all of these communities

The fourth point is that while the National Bureau of Standards has had this responsibility supplying the flow—the needed flow of data mandated to it by law, it has not had the budget to be able to carry out that responsibility. The budget of the national standard reference data system has been essentially flat since it was created, until recently when it dropped. There was a proposal made with—within the Department of Commerce from the Bureau of Standards for an increase in initiative for what was called their engineering data. In reality, because of the very broad nature of engineering, I would say it's a broader initiative than just engineering data. But that initiative did not get through the Department of Commerce.

The inference I'd like to draw, the fifth point I'd like to make of these six, is that, in my view and the view, I think, of the Numerical Data Advisory Board, the Department of Commerce is not using its budget as efficiently as it ought in the sense that it is inhibiting the Bureau of Standards from carrying out the activities that the Bureau's clients consider vital for the continuing and the advancing of their own innovative technologies.

So I would like as my sixth point to urge, first, that this committee consider specifically authorizing increases in support for the data activities to meet the needs of these—of this user community and, finally—finally, of those six points, I'd like to suggest that you might wish to examine whether the National Bureau of Standards and other such vital but highly professional institutions find their proper homes in the Cabinet departments where they're now placed.

There's one other point separate from the rest, but one that I want to raise with you that is terribly important for the functioning of the National Bureau of Standards in the supplying of its standards and data services to the industrial community. At the moment, there is a freeze on the hiring of civil service personnel in the levels GS 11 to 15. In most Government agencies, people at these levels are administrators. At the Bureau of Standards, and other Government laboratories such as the Naval Research Laboratory—these positions are filled by the working scientists.

The Bureau of Standards has on its staff many very, very skilled people who carry out the metrology, the calibration services, on which industry depends. These are truly highly skilled positions. They require very well trained scientists and they require a great deal of experience in judgment. Many people in these positions have been at the Bureau for a long time and are retiring. Unless the Bureau can find a way to hire replacements soon, we'll be in a situation where there'll either be no one to do these jobs, or we'll have to bring in people when those who have the skills are already gone. We'll have—industry will have to go through a suffering period of having their work done by able, but still untrained, green scientists, young people who don't know the fine skills. We have to get—unless we are willing to spend a great deal of money eventually for a little saving in the short term, we have to get young people into these positions to get them trained before their potential teachers have retired.

With that, I'll close, Mr. Chairman.

[The prepared statement of Dr. Berry follows:]

Congressman Walgren, Ladies and Gentlemen:

Let me thank you for this opportunity to speak at your authorization hearings for the 1986 fiscal year budget of the National Bureau of Standards (NBS). In 1981 I testified at your hearings reviewing the National Bureau of Standards Organic Act. At that time I illustrated the essential role of the NBS in furthering commerce, especially high-technology commerce, with some nine examples that were then quite recent, and four examples in which cutbacks in NBS programs had thwarted or retarded innovative progress. My point was then to persuade this Subcommittee of the importance of NBS to contemporary American life.

Since then I have become still more familiar with the NBS and have tried to learn something about the Department of Commerce, of which NBS is one component. As a consequence of this bit of continuing education I've undergone, I'd like to argue for a position somewhat more extreme than I took in 1981. This position may seem bizarre at first hearing but I'd like this Subcommittee to consider it seriously, and examine its implications. I'll present this view and then turn to its relevance in the context of these authorization hearings, particularly with reference to the NBS role regarding data evaluation and data bases.

An Irreverent Position

The major point is this. While the parent institution of the NBS, The Department of Commerce, is probably useful, there are certain organizations within that Department without which our modern, complex, technological society could not function as we now know it. The National Bureau of Standards is one of these; I would put on that list the National Oceanic and Atmospheric Agency, The Bureau of the Census, and perhaps the Patent Office and the Bureau of Economic Affairs as well. In essence, the NBS is far more important to all of us than is its parent Department; the nation would carry on reasonably well without the Department of Commerce but it could not continue without NBS.

Seeing the detailed functions of NBS in supplying American industry with crucial basic data, calibration services, measurement skills and the understanding of how to use all these has taught me how much we depend on the Bureau of Standards. Its role is a quiet one because its work is not controversial; its existence is probably not even noticed by most people. Yet they could not have the kinds of satellites, television, telecommunications, reliable electrical power supply or national defense system that we have now were it not for the NBS, the world's leading institution for basic standards.

One of the most important functions of the NBS is the generation, evaluation and dissemination of basic scientific and engineering data. The role of NBS to oversee and help carry out this task for physical, chemical and much of materials properties data was defined concisely and clearly in the Standard Reference Data Act of 1967, Public Law 90-396. This Public Law, together with its explanatory text, says that "The Secretary [of Commerce] is authorized and directed to provide or arrange for the collection, compilation, critical evaluation, publication and dissemination of standard reference data."

Science, engineering and modern technology depend not only on a static reserve of reliable scientific and engineering data. They all change continually, and we want them to change. Consequently they depend on a flow of reliable data. The kinds of data our technology needs range from ever more accurate values of the fundamental constants of nature to trustworthy ways to estimate the strengths of new composite materials under various weather conditions. Unfortunately, many of the users of these data, particularly the users in high-technology industries, are now saying that the data streams they need for the health of their enterprises are drying up. Many instances of this problem were brought to light in the Workshop sponsored by the Committee on Science and Technology in April, 1983. At that Workshop, corporate officers from many industries discussed their current difficulties in getting necessary data and the consequences of not having those data. (I myself hear of such situations regularly in my position chairing the Numerical Data Advisory Board of the National Research Council.) A bibliography is appended, giving a list of reports that document the users' needs for data in a variety of fields.

It might be charged that if those data are so vital, then the firms that need them could generate them. This argument may apply in other contexts, but it becomes specious when one tries to apply it to basic scientific and engineering data. The costs of setting up the facilities and acquiring the skills to carry out such measurements are sometimes extremely high in time as well as in money, so it is only economical to acquire whole bodies of data in systematic ways. Why, then, do private firms not generate, evaluate and distribute the data? In fact in a few instances they do. However the kinds of data with which NBS deals frequently depend on a significant basic investment into research on how to make reliable measurements, on top of which are the costs of supplying the data or measurement service to the client. The current practice of NBS is of course to charge the client the marginal cost of supplying the data or service. The benefits of those data or services are actually far too widespread, diffuse and public for their full supporting research and development costs to be capturable by any vendor. The data generated or evaluated and the services provided by NBS epitomize the concept of a public good, for which public expenditure is entirely justified. This, incidentally, is a position with which I believe the Office of Science and Technology concurs, on the basis of the conversations I have had with people in that office.

An Aside on the Fundamental Constants

At this point it is perhaps worthwhile to introduce a little explanation of one of NBS's least understood basic scientific data activities, the determination of the fundamental constants of nature to the highest feasible level of accuracy. I say "least understood" because I suspect that most laymen would guess that this is one of the dullest tasks a person could perform. Nothing could be further from the truth, in fact; there is even a kind of romance to this subject that raises it to a level of high art. (Incidentally I do not carry out such measurements myself; I try to pay close attention to those who do, but I haven't the talent or skill it requres.) Let me try to explain this.

First, it is a wondrous thing that there are fundamental constants at all: the elementary charge and mass of the electron and proton, the speed of light, the strength of the elementary atomic "magnets," the fundamental quantum of action, the number we call Avogadro's number, of molecules in a box of gas (under specified conditions), the gravitational constant giving the proportionality between force and the masses of two objects, and the dimensionless, mysterious "fine structure constant." There are only about thirty such constants so far as we know now. Some are very well known: the speed of light is known to be about four parts in one billion, and needs to be almost that well-known for accurate guidance of spacecraft. Others are not so well known: "big-G," the gravitational constant G in the relation

Gravitational force of attraction between objects 1 and 2
= G x (mass of 1) x (mass of 2) ÷ (square of distance
between 1 and 2)

is only known to about five parts in 7000. We do not know of relations to connect different fundamental constants or derive some from others; there is an irreducible set, at least within our present understanding. And of course there are useful, derived combinations of those basic few. Nor does the idea that they are constant go unchallenged. But so far as we can tell now, they are constant and we need to know their values for virtually every high-technology task we perform.

The high art enters in the conception and execution of measurements of these constants at the very edge of our scientific capability. It is common, not rare, for the process of finding a more accurate value of a fundamental constant to push the frontiers of science. The world's most stable lasers, with the most sharply defined frequencies of radiation, are those at the National Bureau of Standards in Boulder and at one of the University laboratories in Paris. These very special lasers were developed for measuring the speed of light and one, at least, will be a stepping stone toward another designed for testing the theory of relativity.

In the late 1970's, a new phenomenon, called the "quantized Hall effect" was discovered. This effect, which occurs in thin conducting films, is characteristic of the electric current when the thin conducting sheet, carrying a current, is placed perpendicular to a magnetic field. The combination of current and magnetic field generate a new voltage which has an associated resistance. This resistance turns out to be quantized in integral fractions of a new fundamental constant, the ratio h/e^2 of the Planck quantum of action h to the square of the charge on the electron. This quantity can be measured to give a new way to help derive h and e, or we can use values of h and e derived from other sources to prescribe, for the first time, a fundamental, measurable unit of electrical resistance. In just the past two years, the NBS has used this new inroad to a fundamental constant to find that the previous (and still) basic standard of resistance, a particular spool of wire, is not constant. In fact the basic standard of resistance was drifting, just a little each year, not enough to have any unfortunate consequences yet, but enough that it is very important to have discovered the drift and to have a natural, constant standard to replace the spool of wire.

The Budgetary Implications

Now I turn to the budget question. The National Bureau of Standards, in its proposed budget to the Department of Commerce, requested $5,600,000 for Evaluated Engineering Data. This was to include the evaluation and compilation of data, the development of methods to make reliable predictions from existing data where new data were needed, the computerization of data sets to make them generally accessible and the establishment of uniform formats for data, the kind of thing that is necessary to make computer-assisted design and manufacturing systems able to share data. This initiative was one of those that did not survive the scissors of the Department of Commerce.

Here is one instance to illustrate the lack of understanding of my first major point. If we are truly trying to make this government operate to maintain the trimmest, most economically efficient operation, then we should be supporting the crucial activities whose existence is necessary for the maintenance of the society and cutting back those things that are helpful but not vital. In short, it is the activities of NBS and other _vital_ agencies that we should keep strong and well supported, and others that we should be cutting back to help ease the deficit.

Conclusion: Addressing the Larger Issue

The situation of institutions such as the National Bureau of Standards, in a Cabinet Department whose agenda does not recognize the society's dependence on those critical institutions, is parlous. Furthermore the interactions between such institutions have sometimes led to very unproductive relationships. I believe that there is, fortunately, no such problem of this sort now between NBS and the Department of Commerce. The problem nevertheless hangs like a sword; we have seen it in other instances.

I would like to close by suggesting that this Committee may wish to consider whether a change of institutional structure might be in order. Specifically, if one recognizes a group of highly professional, nonpolitical institutions whose tasks deal with and whose effectiveness depends on objective collection, evaluation and dissemination of reliable data, then it might be well to put these under a single "National Laboratory Administration," a weak structure within which each of the institutions could perform its crucial tasks quietly, out of the political hurly-burly so irrelevant to its function. This suggestion is open to further elaboration if the Committee wishes to pursue it. In any event, the problem I first addressed remains and grows larger as our increasing technological sophistication makes us rely more and more on the skills and services of agencies such as the National Bureau of Standards. We must protect them and nurture them if we expect to depend on them.

R. Stephen Berry was born in Denver, Colorado in 1931. He attended school there. He received his university education at Harvard (A.B., 1952, A.M. 1954, Ph.D. 1956). He remained as an Instructor at Harvard during 1956-57. From there, he went as Instructor to the University of Michigan. In 1960 he went to Yale University as an Assistant Professor and in 1964, as Associate Professor to the University of Chicago. He was made Professor in 1967. Since 1975, he has held a joint appointment in the Department of Chemistry and the Committee on Public Policy Studies at the University of Chicago. His research has been in physical chemistry and in energy and resource allocation. His research in chemistry has dealt with atomic and molecular processes and with thermodynamics. He is coauthor of a book on the social costs of coal and nuclear power and also coauthor of a treatise, Physical Chemistry. He was Guest Professor at the University of Copenhagen in 1967 and 1979, Professeur Associé at the Universite de Paris-Sud in 1979-80, the first Hinshelwood Lecturer at Oxford University, 1980, and Visiting Fellow of the Japan Society for the Promotion of Science in 1984. He currently chairs the National Research Council Review Panel for the Center for Basic Standards of the National Bureau of Standards. He is a Fellow of the American Academy of Arts and Sciences, A Foreign Member of the Royal Danish Academy of Sciences, a Member of the National Academy of Sciences and a MacArthur Fellow. He is married and has three children.

STUDIES AND ARTICLES DEALING WITH NEEDS FOR RELIABLE PHYSICAL, CHEMICAL, AND MECHANICAL PROPERTY DATA'

A SELECTIVE BIBLIOGRAPHY
MARCH 1984

Towards a National S&T Data Policy: A Workshop - coordinated by Committee on Science and Technology, U.S. House of Representatives; Congressional Research Service, Library of Congress; Numerical Data Advisory Board, National Academy of Sciences, 1983.

This workshop approached the question of establishment of a national scientific and technical data policy through a number of talks and discussions which examined data requirements in industry, agriculture, and other sectors. Many specific examples were given of the benefits of reliable, widely available data bases.

Gilbert Gude, Director, Congressional Research Service, said in his concluding remarks:

"Scientific and technical information will be vital to the growth of high-technology industries in the future as well as to the revitalization of today's manufacturing and agricultural sectors. Effective management of these information resources has the potential to boost productivity and increase the competitiveness of American business. The ability of policy makers to respond to changes brought by scientific and technical information and to provide guidance for the utilization of these resources will have a direct impact on the economic and social condition of the Nation in the future."

National Needs for Critically Evaluated Physical and Chemical Data - Committee on Data Needs, Numerical Data Advisory Board, National Research Council, 1978 (Walter H. Stockmayer, Chairman).

This is the report of a study on data needs, current U. S. efforts to produce evaluated data, and the benefits to be expected from a comprehensive evaluation program. The major recommendations were:

"1. The present annual support for organized data evaluation activities of slightly under $7 million should be increased over a period of five years to $18 million. For reasons outlined in Chapter 8 this support will have to come primarily from the Federal Government.

2. When a particular mission relies heavily on results from a field of research, responsibility for data compilation and evaluation in that field should be accepted by the agency responsible for the mission. The Office of Standard Reference Data of the National Bureau of Standards should be responsible for categories of data of very broad utility and for general coordination of the overall system.

3. Each agency should be required to place its responsibility for data compilation and evaluation on one key official at a level high enough to ensure that the agency's responsibilities in this area will be fulfilled."

The Department of Energy: Some Aspects of Basic Research in the Chemical Sciences - Committee on Chemical Sciences, National Research Council, 1979 (Robert E. Connick and Bryce Crawford, Jr., Cochairmen).

This NRC report assisted the Department of Energy in defining its needs through a look at basic chemical research in selected fields, as well as certain research policy issues.

Under research policy issues, a section on Critically Evaluated Data contained the following:

"The Directors of the Divisions of Materials Sciences and Chemical Sciences of OER have both expressed to this Committee their concerns about the inadequacy of reliable evaluated data. Data needs related to DOE programs range over chemical sciences in the broadest sense, from spectroscopy to combustion engineering, from solid-state properties to corrosion. Chemical data pertinent to DOE programs include spectroscopic constants (from X-ray to nmr) for atoms, ions, and gaseous molecules; fundamental kinetic and transport data, such as rate constants, diffusivities and conductivities; thermodynamic data (including data for surfaces and data at extreme conditions); crystal structures and phase diagrams; electrochemical data; state properties of solids, liquids, gases, and plasmas.

Data evaluation requires a considerable investment of time and money in the initial installation of literature-retrieval and data-processing techniques; data evaluation also requires highly trained people. For these reasons, it is important to ensure the continuity of groups with experience in critical evaluation and tabulation. The recommended program of continuing evaluation will have long-term applications for a wide range of fields, and it is essential to maintain a level of activity that will keep pace with the flow of new data in the literature."

Improving R&D Productivity: The Federal Role - Lewis M. Branscomb, Science, 14 October 1983.

This article focuses on the importance of evaluated data to R&D productivity, and the Federal role in assuring the availability of such data. The article summarized:

"Despite widespread concern about lagging productivity growth rates and renewed interest in research, federal support for the review and packaging of hard-won new knowledge continues to languish. Yet accurate, accessible data are critical, not only in every R&D project but also in the most advanced manufacturing processes. Ensuring reliable, retrievable data is not a function that can be left to the professional societies, the publishing industry, or the private sector. In this article a six-point national science and technology data policy is proposed, and it is suggested that progress ultimately will depend on an overall science and technology policy, the first priority of which is to make available existing knowledge."

Materials Properties Data Management - Approaches to a Critical National Need - National Materials Advisory Board. National Research Council, 1983 (William F. Brown, Jr., Chairman).

This report results from a study of the needs for storage, dissemination, and analysis of materials properties data vital to the design process. One conclusion of this report states:

"The federal government and the private sector should work cooperatively to establish a national computerized materials properties data bank network that would efficiently provide carefully evaluated information to our industrial designers. Active participation of the federal government is initially required because start-up costs cannot be rapidly recovered and because the whole nation will benefit from the existence of such a network."

Computerized Materials Data System: The Proceedings of a Workshop Devoted to Discussion of Problems Confronting Their Development - J. H. Westbrook and J. R. Rumble, Jr., Editors (1982).

These are the proceedings of a workshop which brought together a number of international experts to discuss the problems associated with the establishment of computerized materials data systems.

As part of the discussion of barriers to such systems the proceedings state:

"Two other important political factors also should be considered. First, a new institutional framework on both the national and international levels is needed to coordinate and manage databases. On the national level an organization that enables all the groups listed above to cooperate has become both necessary and urgent. Internationally the need is greater because of language and nomenclature problems and the previously mentioned obstacles to data flow across national boundaries. Second, the timing of the creation of a comprehensive database system through the gateway concept is critical. It is a distinct possibility that a system of databases developed elsewhere--for example, Japan--will offer such compelling and efficient services that the rest of the users in the world will turn to it because of necessity and cost/benefit advantages. Also, a Tower of Babel effect could soon come about for lack of a coordinated development of mutually compatible files, languages, and database management systems. That is, over a short period of time so many independent databases could develop that bringing them together later in some kind of effective, rational functioning unit might become well-nigh impossible."

Mechanical Properties Data for Metals and Alloys: Status of Data Reporting, Collecting, Appraising, and Disseminating - Panel on Mechanical Properties Data for Metals and Alloys, National Research Council, 1980 (James A. Graham, Chairman).

This report assesses the status of mechanical property data compilation and evaluation and recommends a cooperative national program to provide the data needed by industry and Government.

The panel recommended that:

"There is a continuing need for the organizations concerned with mechanical properties cooperatively

(a) To develop and improve the uniformity of test methods and data reporting;
(b) To develop definitions of nomenclature and properties;
(c) To develop property data appraisal procedures;
(d) To disseminate data including those evaluated in the process of developing test methods;
(e) To provide lists and disseminate information on test methods, data reporting, measurement standards, definitions, nomenclature, and appraisal procedures;
(f) To coordinate data efforts and assess data needs through organizing active committees, symposia, conferences, workshops, and other methods."

Thermophysical Properties for Synthetic Fuels - (A report prepared by the Working Group on Thermophysical Properties of Synthetic and Related Fuels for the DOE, J. Kestin), Chairman, 1982.

This report surveys the need for a data base of physico-chemical properties of substances required by the emerging synfuels industry.

In the conclusion, steps leading to the creation of a reasonable data base are listed.

"The steps which it is necessary to take consist of

- the development of methods to sample and to characterize samples from process streams

- the development of improved predictive correlation methods to cope with the increased complexity

- the creation of a base of carefully performed measurements on pure components and on prepared mixtures for the validation of correlations

- the expansion of existing experimental facilities in the country in support of the program of measurements

- the creation of a mechanism or center for the coordination of activities and to secure a continuous exchange of ideas and methods between industry and academic and government laboratories and between experimentalists, theoreticians and correlators."

Transactions of the Conference on Thermodynamics Research Requirements on Fossil Fuel Processes - Science Applications, Inc., 1979.

The objective of the conference was to consider classes of thermodynamic research essential to the development of a program for the Fossil Fuel Extraction Division of DOE. Strong emphasis was placed on thermodynamic data requirements.

The following statement was part of the overview of the section on Thermodynamic Properties:

"In the following section, topics of the highest priority are described to provide design engineers with data for sound process design. It is recognized that equations-of-state ranging from cubic equations of the van der Waals type to corresponding states and group contribution descriptions would be an effective way of using a minimum of laboratory data to describe a wide variety of relevant process thermodynamic properties. Implicit in such equation of state development is the need for fundamental data in areas such as molecular dynamics. Also experimental measurements to support parameter determination for equations of state are needed.

Equations of state must be developed to handle multicomponent, multiphase predictions. It would be desirable if these predictions can be made using experimental measurements on binary systems."

Value of the Energy Data Base - King Research, Inc., 1982.

This report documents an assessment of the Energy Data Base (EDB) of DOE's Technical Information Center. The EDB provides access to a broad range of information in the world's energy literature, of which numerical data forms one component. The study attempted to quantify the benefits of making this information readily available to the energy R&D community. One paragraph in the Executive Summary states that:

"The latter figure, $3 billion savings in labor and equipment from the EDB products and services, can be roughly translated into productivity. If it is assumed that, with the EDB, research and development costs $5.8 billion for a given level of output, without the EDB the same output would require an investment of $8.8 billion. This is an increase in productivity of about 52 percent. This says that to accomplish the same R&D output without TIC information services, the R&D budget would have had to have been $3 billion higher."

Development and Use of Numerical and Factual Data Bases - AGARD* Lecture Series No. 130, North Atlantic Treaty Organization, Oct. 1983.

(*Advisory Group for Aerospace Research and Development)

An international group of speakers presented a two-day program of talks on reliability, availability, accessibility, utilization, and management of numerical data bases. The written versions of these talks are contained in this volume.

The Preface states:

"Numerical and factual data, as sources of information for all levels of aerospace and defense R&D management and staff activity, are becoming increasingly important. These data are necessary to support research and engineering efforts in all fields. They are also becoming increasingly important to support or assist in the decision-making process. Today, a number of numerical data bases are available through national information centres and others are available from academic or commercial information sources. Data in many of these data bases can be retrieved and manipulated in display systems currently available. There is, however, a great need to improve the quality, reliability, availability, accessibility, dissemination, utilization and management of these data."

Workshop on Data Quality Indicators: Summary Report and Recommendations - sponsored by Chemical Manufacturers Association, 1982 (Carlos M. Bowman, Chairman).

This workshop addressed the need for more reliable data and better methods for indicating the level of reliability. The emphasis was on data relevant to environmental quality and health effects. From the Executive Summary:

"The proliferation of computerized data bases has increased the amount of data and information available. Unfortunately, many of these data bases do not provide the user with any indication of the quality of the data retrievable from the system. Tracing the origins of a particular value is often difficult, if not impossible. Association of appropriate quality indicators with the information in these data bases could provide a user with sufficient information to judge the applicability of a particular datum value for a specific use."

Current Trends in Atomic Spectroscopy - James J. Wynne, Physics Today, November, 1983.

Current activities and trends in atomic spectroscopy are discussed in the context of new experimental tools such as synchroton radiation and lasers, and the needs for evaluated spectroscopic data are outlined for a variety of applications. In a major section on Compilations and Tabulations, the author states that:

"Data banks containing the best values of the measurable quantities of a field are an indispensable addition to the primary literature. In atomic spectroscopy, these data banks include refined and evaluated information on quantities such as line positions, line strengths and energy levels. The entries either come from laboratory measurements or from various theoretical or empirical calculations. Evaluated data are important to the scientific community for a number of reasons, including the following:

- The process of compilation often reveals fundamental inconsistencies or conflicts in the data

- Applied spectroscopists require a rapid means for obtaining reference data
- The compilations are a pathway to the primary literature, which presents the experimental and computation work
- Theorists depend on reliable data with which to develop models and compare their predictions
- The compilations indicate the state of our knowledge.

Report of the Subcommittee on Energy-Related Atomic and Molecular Science - Committee on Atomic and Molecular Science, National Research Council, 1976 (Benjamin Bederson, Chairman).

This report documents the significance of atomic and molecular science to energy-oriented research, development, and technology.

In the Appendix on "Scientific Data: Evaluation and Dissemination," the subcommittee concludes:

"One of the more complicated aspects of the application of atomic physics or chemistry to research in the field of energy is the diversity and the magnitude of the various programs. A partial listing of the energy research programs in which atomic or molecular data are needed would include all the areas discussed in this report. Established data centers are in a position to supply most of the atomic needs of these various programs. The chief need for an additional data center is probably for molecular data; a 'Data Center Steering Committee' could provide a valuable focus for establishing national data accumulation and evaluation policies in atomic and molecular science and for serving as a clearinghouse for channeling data requests by users."

Current Trends in Atomic Spectroscopy - A report prepared by the Committee on Line Spectra of the Elements - Atomic Spectroscopy, National Research Council, 1984 (James J. Wynne, Chairman).

This report includes a review of existing atomic spectral data bases and summarizes gaps in our knowledge of atomic parameters. In regard to computerized data bases, the report states:

"A major problem associated with modern data compilations is that of making the information readily accessible. Recourse to highly automated procedures is inevitable and essential for speed as well as convenience...the necessary hardware is readily available and there are no technological roadblocks for immediate implementation."

ADDENDUM including some geo- and biosciences data needs studies

Solar-Terrestrial Data Access, Distribution, and Archiving, Space Science Board, Committee on Solar and Space Physics, Board on Atmospheric Science, Committee on Solar-Terrestrial Research, National Research Council (1984).

This report addresses the needs to develop management methods for solar-terrestrial data that are being collected at the rate of several mag-tapes a day. The efforts expended in measuring the data for many potential data users are futile because of inadequate documentation and achieving of the data on the tapes, rendering them inaccessible in practice. Other reports from the NRC dealing with the subject include:

"Geophysical Data Interchange Assessment 1978," and
"Geophysical Data Centers: Impact of Data-Intensive Programs" (1976).
"An Assessment of the Impact of World Data Centers on Geophysics" (1975).

Data Management and Computation. Volume 1: Issues and Recommendations, Committee on Data Management and Computations, Space Science Board, National Research Council (1982).

The report studies the steps in the data chain from satellite measurements to ground to preprocessing to principal investigator to reduction and analysis and archiving and gives recommendations in each of these areas. Insufficiencies encountered include administrators' and scientists' indifference (and funding) given to the program management of the very data being sought, as well as technical inadequacies. Volume 2 is in preparation.

Need for a Multipurpose Cadastre, Panel on a Multipurpose Cadastre, Committee on Geodesy, National Research Council L980).

The need for a common framework within which to express and exchange land information has been expressed. Land information is being gathered at all levels of government and in the private sector. The report considered the basic components (reference frame, base map, and cadastral overlay) of a multipurpose cadastre which, if properly established and maintained, would provide a common framework for all land-information systems.

Workshop on Data Documentation Quality Indicators, sponosred by the Chemical Manufacturers Association May 8-9, 1984, National Library of Medicine (Curtis Elmer, Chairman).

This workshop provided a medium for continuation of the work started in the 1982 Workshop on Data Quality Indicators, listed in the bibliography. The concern is that in computer accessing of data sets, the quality or reliability of those data need to be made clear to the data user. This refers to physical and chemical databases as well as those relevant to environmental monitoring, biology, ecology, and epidemiology.

Mr. WALGREN. Thank you very much for interesting statements, all.

Each of us has his own frustrations and I keep thinking that although we're all trying to respond to budget cuts, Everett Dirksen would not describe these programs as real money. He would reserve those kinds of reductions for programs that dealt with greater amounts than we're really talking about in any of these programs. And hope that we in the Congress can sort that out.

Let me state, on the same note of frustration, that we recognize as a committee that the personnel policies that are proposed to be applied at the Bureau of Standards and are dictated by broader Government agencies and which may be appropriate at other agencies, seem to be literally more than self-defeating in the Bureau. They are downright destructive, both in terms of hiring freezes or salary reductions, or whatever has been proposed. We hope the Congress is able to sort that out as well and distinguish between Government functions that we see in other agencies and NBS's functions of Government.

I wanted to ask Dr. Seitz, with respect to the cold neutron facility, does the NBS proposal adequately address the long-range recommendations of the committee that you chair?

Dr. SEITZ. Yes, we gave it, you can see from the statement I've made, top priority in the group of upgrades. I want to emphasize that the Europeans at present have a very large laboratory in France that is far ahead of anything we have. By adding the facility that we're describing here to the reactor at the National Bureau of Standards, we'll take a first step in closing that gap. We'll need to do other things, but at a somewhat slower pace.

Mr. WALGREN. Do we exclude the Europeans, at least on a priority basis, to the same degree that I sense we are excluded——

Dr. SEITZ. In general, we have welcomed cooperation when it fits into our pattern. Of course, at the present time, the Europeans have enough of their own, so that they in general haven't come to us, although there are some exceptions.

I think my colleague, Dr. Berry, would like to supplement my comment.

Dr. BERRY. I know the facility at Grenoble moderately well, and I think the Europeans feel that there's absolutely no need for them to bother coming to the United States they are so far ahead of us.

Mr. WALGREN. But how about other kinds of facilities?

Dr. BERRY. Well——

Mr. WALGREN. I gather we have a right to at least expect equal treatment.

Dr. BERRY. In places like Fermilab, the Europeans certainly participate.

Mr. WALGREN. Well, I wish they would——

Mr. BERRY. We participate at CERN as well.

Mr. WALGREN. Uh-huh.

Dr. SEITZ. That's in a very different field, but nonetheless, an important one.

Mr. WALGREN. You have really touched well on the points that were raised in advance by our review of your testimony, Dr. Seitz, and we certainly appreciate that much.

Dr. Prindle, as I understand the advanced ceramics initiative at NBS is for $3½ million, is that right?

Dr. **Prindle**: Correct.

Mr. **Walgren**. Can that be a significant effort in contributing along the lines that you would feel NBS can make that contribution?

Dr. **Prindle**. Yes, it's a substantial improvement over what they have now devoted toward these same issues in the ceramic field. A $3½ million increase, as you commented earlier, sir, is not an effort that's going to save all the problems.

Mr. **Walgren**. Yes.

Dr. **Prindle**. However, I think it's an excellent way to begin.

Mr. **Walgren**. Let me ask—if I might, Dr. Seitz, I do feel that some of the others may want to ask you about specific points, so please, if you would stay and make yourself available to them, I know that they would appreciate it.

Dr. Prindle, you really emphasized the importance of coordination and linkage between information. You emphasized that the Bureau personnel are very good, from your viewpoint. Is that how you view the talent at the Bureau in this particular area?

Dr. **Prindle**. They have some outstanding scientists. Some of the areas there are certainly world-class laboratories. To just pick one, For example, the work that Dr. Wiederhorn and his colleagues are doing in the fracture analysis of materials is leading many parts of the field on a worldwide basis. There are many very skillful people at the Bureau, but as Dr. Berry has commented earlier, they are fewer today then they were 5 years ago, and fewer 5 years ago then there were 10 years ago. I think we've all witnessed an erosion in the number of top scientists at the Bureau, but there's still a cadre of very competent people that are dedicated and are certainly recognized as being well qualified.

Mr. **Walgren**. This is a most interesting panel all in all and I think the other members might feel the same way because you seem to be coming at what are some pretty concrete benefits to specific industries with real justification for a governmental role. We had been frustrated by ideological approaches which have sort of boxed us off, and there was some argument that we're picking winners and losers by investing any Government effort in an area that might have specific application.

I gather, Dr. Prindle, that when you emphasize communication—now that's a pretty generic function and might very well be done by some other entity other than Government if we wanted to resist Government doing it. But what I sense you're saying is that we have practical gap here, or a gap in our functioning, and that there's a tool which can bridge gap, and there's no real reason not to use it in the dimensions that we're talking about.

Dr. **Prindle**. Correct. My emphasis on communication, was with respect to skill that the Bureau exhibits in technology transfer. They communicate very well what they've observed.

I think one of the problems that I alluded to is that what's everybody's business is nobody's business, in the sense, that there are lots of uninspiring small bits of data that have to be collected to fit this network together. Industry isn't going to do it because it's not cost effective to do that work. Universities aren't going to do it because no young professor's going to get tenure for doing something that's off in one corner of a system. So the Bureau serves a real underlying coordinating function, which I think it very important.

Mr. **Walgren**. And no nonprofit agency would do that, no association, no society.

Dr. **Prindle**. Societies and associations do parts of this, but it's parts that serve their own interests. Trade associations, obviously, are interested in their business aspect; professional societies oftentimes go with what's popular, what's fashionable; and I think the Bureau has had a solid record of being very responsible about some of the basic phenomena that have to be studied.

Mr. **Walgren**. Dr. Seitz.

Dr. **Seitz**. Another great virtue of the Bureau, which is somewhat complementary to that, is that it has the tradition of starting an interest in a field that it knows will be important over a very long period of time, developing deep-rooted expertise in that field, and being available. Let me give one good example that struck me over the years. The Bureau in our country took the initiative in trying to understand what the safety limits should be for, say, x-radiation in connection with medical practice or in other applications. Over the years, it has sustained that interest and refined it, and as a result has rendered enormous service both to medicine and to other aspects of applied science.

Mr. **Walgren**. I see.

Well on my personal part, I'd like to thank you all very much, but I want to give the other members an opportunity to raise subjects with you. The Chair would recognize Mr. Boehlert.

Mr. **Boehlert**. Mr. Chairman, just to follow up on the—on the exodus of top technical people, that's something that really concerns me also. And I'm struggling to come up with some sort of remedy. And I hope that you would focus, all of you, a lot more and share with us some additional thoughts.

I mean it bothers me, for example, to think that in one area, the Navy, where we're short of pilots, we're offering up front $36,000 bonuses for the pilots to sign on for an additional 6 years. I don't quarrel with that. We need good pilots in the Navy. But I quarrel with a proposal that says to our top technical people and the civilian sector of our Government that we're going to perhaps cut their pay, we're going to freeze them in at their existing grade level, we're going to offer no incentive for them to continue doing what they have been doing, I think, very effectively. And I would hope you would all focus more on it.

Yes, Dr. Berry.

Dr. **Berry**. Well, let me say that at the time I finished graduate school, the National Bureau of Standards was considered one of the prime places in the world to get a job. In fact, one of my more senior colleagues was saying exactly this the day before yesterday to me when we were talking about the Bureau of Standards. And we do, we worry about the Bureau of Standards, because now, although it's a good place to go, it's not at the status level that it was 20 years ago, 30 years ago.

Mr. **Boehlert**. Is it because of the compensation level or is the challenge somehow not there?

Dr. BERRY. It's partly because the positions are not there, because the staff is aging and it doesn't have as high a proportion of people working at the cutting edge. It has reduced its cutting edge work in order to go back and to carry out its absolute bare-bones base functions, because it hasn't had the means to maintain its cutting edge role. So it's been less attractive to the more creative, more innovative young people.

Right now they are virtually not hiring at all, and we don't know when that will change. This is a very——

Mr. BOEHLERT. Well, I just—I'm sort of perplexed by the whole thing, and I just hope you will continue to speak out as you have here. And I know, Mr. Chairman, we've heard this same message before, and I think we've got an obligation up here to do something about it, too.

One further question, if I may, for Dr. Prindle. When you're talking about ceramics in the negative trait—traits, the brittleness and propensity to unpredicted catastrophic failure, to quote you exactly. Now everybody's focusing on the use for engines, automobiles, airplanes and everything else. You know, if this brittleness factor's not overcome, we've got a serious problem. What's being done to monitor the fatigue factor for the eventual users?

Dr. PRINDLE. Help is on its way.

Mr. BOEHLERT. That's good news.

Dr. PRINDLE. Yes. The bad news is it's going to take some time before it's fully realized.

There is a family of ceramic materials which are characterized as ceramic composites in which the ceramic matrix is reinforced by another ceramic in fiber form, such as silicone carbide fibers, for example, in a glass-ceramic matrix. These systems have the characteristic of a substantial improvement in toughness and reliability over monolithic ceramic materials. It's the same type of philosophy that has built the reinforced plastics industry, where one takes polymers that have certain weaknesses and one reinforces them with glass fibers and they have a much greater strength and adaptability as a composite. The same thing has been done with metal matrix composites.

So we believe that that advent and the development and utilization of ceramic composites are going to solve a great number of these reliability problems.

Mr. BOEHLERT. Who's doing that work right now?

Dr. PRINDLE. It's being done in some of the National Laboratories. It's also being done by a number of the major ceramic manufacturing companies.

Mr. BOEHLERT. And one further question, then I'll defer because I know a lot of my colleagues have questions. How——

Dr. SEITZ. I might add one comment there, that nature has used this principle very effectively in our bones and teeth, and elsewhere.

Mr. BOEHLERT. Stop reminding me.

How about—do you agree that the destructive testing and predict—predictability of the ceramic engine should be explored? Should we be doing more in that area?

Dr. PRINDLE. I think that the progress that's been made in recent years in gradually adapting ceramic parts to the less critical parts of engines shows that we can solve a lot of these problems. We are not going to see a real ceramic engine a year from now, that's actually a working, installed engine, but I believe that 15 years from now, we will see engines where we have piston tops and many components which are constructed of perfectly reliable ceramic components.

I don't know if I answered your question or not.

Mr. BOEHLERT. All right, thank you.

No more questions, Mr. Chairman.

Mr. WALGREN. Mr. Henry?

Mr. HENRY. Thank you, Mr. Chairman.

I'm one of the new members on this subcommittee so, much of this is very new to me, particularly the bureaucratic structuring in the government. But conceptually, I have kind of a love triangle in my mind, as it were, of three legitimate interests all competing and wondering where they fit in, the kind of—the concern of the pure scientists, and the universal community with dissemination of knowledge. And at that level, saying, get this data out. And at the same panel, someone who's looking, realizing I need that basic research, I need basic standards, but my primary interest is commercial application, and I'm not sure whether I want that data out, an l wondering and trying to find the line conceptually. Should this kind of basic research ought not to be explored in trying to think of other countries and how they're handling this?

I mean, clearly you need—on the Bureau standards and some of these fundamental measuring—that's all a mental—it's like trying to write without a dictionary, you know, to put it in a—or without rules of grammer.

But don't we come to a point when these questions are increasingly the basic stuff of—of technological leading research, too? And so, while it's fundamentally instrumental to the advancement of science, as weights and measures might have been in the 17th century over time, the whole issue of time and clocks, it's commercial utility. It's so important to this technological race.

In these European labs that you make reference to, do they disseminate the data as freely as we do? Have the norms of science continued to reign over what you might say over national economic interests? Are they as good at information dissemination as we are?

Dr. SEITZ. By all means. I grew up in a period when Europe was in the main well ahead of us in all of these things. I recall that in the 1930's, for example, I frequently used European reference books for data. Some of the data in it had been determined on this side of the Atlantic, but the Europeans have a long tradition of publishing handbooks of data.

Mr. HENRY. What would have happened commercially if this—the Hall effect to which Dr. Berry referred had been found instead in one of the advanced labs of RCA or something like that in terms of the electronic industry and kept it to themselves as proprietary information——

Dr. BERRY. Nothing.

Mr. HENRY [continuing]. Down the road got such ad on the market in terms of more—more reliable electronic data transfer and all that would come off it?

Dr. BERRY. Well——

Mr. HENRY. What are the ethics of that and what would have happened, and would we be better off going that route? I'm just—it's all new to me, so just——

Mr. BERRY. It's a very, very reasonable set of questions you asked, and it's one that the scientists, especially in the industries that maintain forefront laboratories—face all the time.

But there is a kind of established ethic. It shows up in something like how the transistor became public. That is, the research that has implications 10 to 15, 20 years ahead of us does get put into the open literature. The research that has implications for products 3 or 4 years ahead of us normally does not.

This is something that we—that someone like myself, as an academic scientist sees, and—let's say I think the academic scientists are very comfortable with the accommodation that industry makes.

Let me give you an example—or a source, I should say. In 1983, the parent committee of this subcommittee asked the Numerical Data Advisory Board to help it organize a workshop to consider questions regarding the national science and technology data policy. The people who presented their positions at that workshop—incidentally, it's the first item in my bibliography—people who presented statements at that workshop were, all but one, people from industry who were specifically concerned with advanced technology and were data users, not data generators. That is, they were the people who had the needs and the people whose firms were going to profit from the data that would—would come forward. To a person, they were able to say there is a category of data which we will generate internally, which we want to be proprietary, and which we have no interest in asking the Bureau of Standards or anybody else to get for us.

There is another much larger category of data which we and our competitors and everybody else in other industries need that we generate, the Bureau of Standards generates, the other industries generate, the universities generate, and the Bureau of Standards maintains surveillance over, the Bureau of Standards maintains the evaluation and compilation responsibilities for. And they are very eager to have these data flow in from all these sources.

So I think the—the problems over whether any particular result will be public or private are almost always very, very easy to resolve. And I think the whole scientific community, including the academics, are quite comfortable with the—with the way things are operating in that regard.

Now, the problem is much more that the data aren't there and they aren't getting evaluated, they aren't getting into computerized data—data bases to which we all have access at the rate that we need.

Dr. LEONARD. Mr. Henry, if I could supplement that from the viewpoint of commercial operations, the availability of data is the important first step, as Dr. Berry has testified here, and there are many adequate ways of utilizing that publicly available data in different commercial ways, many of which come under the heading of know-how. It's there where we protect our competitive advantage, not in the generation of the basic data. We need both, but one cannot exist without the other. So the discretionary decision of what to protect and what not to protect lies at that interface between generation of the basic data and the utilization that in the commercial end. That responsibility falls primarily on those of who are in the commercial end.

Mr. HENRY. Yeah. What I was saying, somehow if you had the basic—basic data uniquely, then only you would ever know how to use it. And that's—that's what I'm trying to get at. And I'm looking at this in terms of the national security, too, and seeing how this budget—and that's one of the other things. We talk about the pay hikes and incentives for commercial pilots and then cutting, you know, our—our basic science. But at the same time within the research, we're seeing so much taken away from this side and put in the Department of Energy, Department of Defense, it's shifting. And what's going on? Are we really doing the same thing but putting it someplace where you and I can't see it? I mean, I don't know. And—and in the Soviet Union, obviously, the whole thing is a very—a very different kind of situation, although I suspect we more than gain through the spirit of scientific inquiry we have than we lose.

Dr. PRINDLE. I would agree with that. I think that there's been long experience in many fields of scientific endeavor which indicate that there is more gain by sharing than from protecting.

What we have to do in order to offset the potential utilization of that basic information by others is simply more rapidly in its utilization. And where we have done that in the past we have been successful as a nation, and where we have not, we've not. You can even think back to the basic discovery of the fission process. That was not done in this country, but because it was at least known to a few scientists, that was utilized rapidly and effectively. That's the pattern that we must follow, because the other choice, to impede the generation and promulgation of the data, leads to compartmentalization which is of no benefit to anyone in the world anywhere. I think that's a long established principle.

Mr. HENRY. Thank you.

Mr. WALGREN. Mr. Ritter.

Mr. RITTER. Thank you, Mr. Chairman.

And I'd like to thank the panel for some very excellent presentations.

I'd just like to comment on this idea of—of free sharing of data. I think it—it has been noticed that certain competitors tend to keep their own data closer to the vest while sharing everybody else's. I won't really mention names, but I think it's becoming quite obvious. And the generation of basic science and the data that—that comes from basic science is one level of output of our American—American abilities and not necessarily the level at which technology advances of commercialization occurs.

That brings me to Dr. Leonard's presentation. We have kind of a unique situation here built upon the successful work in sensors that NBS has coordinated. We have the very successful work that NBS has coordinated along with industry on the development of alloy phase diagrams. You have to be a metallurgist to know what that means.

But it is awfully, awfully important data generated for progress in our metals industries across the length and breadth of this economy. But now we are talking about an expanded role of sharing the, ah, the production of data, the sharing of the research process, the sharing of the technological—the technology evolution between industry and government. Some would say that this is going too far, it's targeting industrial policy.

How do you respond to that?

Dr. LEONARD. Well, my opinion there, Mr. Ritter, is that this is not a matter of going too far; this is an opportunity which we in the United States must seize. And that, to make this recompetitiveness occur, I think that's very fundamental to many industries, not just steel, by the way. We've got to find some kind of alliance between all of the forces which can be brought to bear on that competitiveness. That certainly includes National Laboratories, NBS, as partners, not adversaries. Or not even neutral measurers of data. It takes more than that as I see it.

And the particular role especially for NBS that I see here is that of catalyst, to bring about an alliance which otherwise is somewhat difficult to do. And I submit to you that at this particular time the pieces happen to be here. Partly because of troubles in my own industry. I have to be the first to admit that. And they are management troubles, by the way; let us make no mistake about that.

But having gone through that we are now at the position of recognizing that and asking for help of all kinds wherever we can find it. And in part that's got to be from our technological and especially our scientific community. Because as we try to compete internationally in these basic industries—and not just steel, there are many—regaining technological edge, advantage, is the only thing we have going.

We certainly don't have going low labor rates. In fact, we have to offset the labor rates which our high standard of living are affiliated with, and the only way to do that that I can see is to run smarter and faster and more effectively in bringing together all of those parts of our scientific and technological community to do that. And NBS is uniquely equipped to do that because this is an extension of their traditional role of identifying long-range trends and bringing about in a quiet way those things that make them cooperate. I think that's the appropriate case here.

NBS in its quiet way has begun some work here which has shown a substantial advantage, and we simply need now to take further advantage of that.

Mr. RITTER. I tend to agree with you. And I think what we're beginning to see is, and NBS is probably at the forefront of it, we're beginning to see this partnership that you talk about. What we're really talking about is sharing brainpower. That is our basic advantage. Our intellectual resources are our scientific capabilities, our educational system that feeds into this.

And I think we in the Congress face some very interesting choices. We spend billions of dollars on long-range fusion research. I'm not an expert as to how many billions we should be spending on long-range fusion research, but we make those choices. We spend billions. We're about to spend billions on a super conducting super collider system, and we do have the world's foremost preeminent high-energy physics establishment. I don't know how many billions we should spend on—in these areas, but we're spending these billions.

Now, you talked about the Keyworth initiative, which is an attempt to take some of this brainpower from the Federal National Laboratories, combine it with brainpower from industry and focus it in certain areas where potential leapfrogs over the competition are possible.

What kind of response have you seen to this effort, and what do you advise us to do in a committee such as this to promote this effort, to make some of these decisions which we make all the time at a level more involved in the ongoing battle between nations in the ongoing arena of industrial competitiveness as opposed to the more far-ranging, long-range research areas?

Dr. LEONARD. Mr. Ritter, you have said that very well. It's very difficult for me to add much to what you've said.

But to respond to your question, I believe that there is, indeed, a groundswell of response. We're beginning to see in many areas new programs evolving through the National Academy of Sciences, for example, on the alliance between government, industry, and universities for competitive purposes. So we have to find the ways to encourage those to come about.

And I would emphasize that these are not massive, high government spending kind of programs. Rather, these are seed money, catalytic kind of programs with rather small, relatively speaking, numbers of dollars involved. And we have—and I think through our congressional process we need to address how we prioritize those kinds of collaborative alliances with seed money involved versus the massive spending approach in certain other areas.

How do we determine, for example, the priority on fusion research versus the priority on getting out some sensor work upon which many other things are built in the commercial sector? Those are very difficult decisions, but in my opinion those are the correct decisions that should be addressed in committee proceedings of this type. I, obviously, think, or I wouldn't be here, that these kind of seed alliance programs, I will call them, are worth every penny and then some. They are very cost-effective programs when viewed in terms of their impact on not only our current economy but our future competitiveness.

Mr. RITTER. I'd like to just underline that for a moment and to perhaps soften the blow or reduce the fears of those who might think that we're onto a synfuels bandwagon or somehow the bureaucracy in the Congress has decided that a massive new industrial incursion is underway. I think first and foremost what we're talking about here is a team approach. And as you—you use the word "alliance." I think that's a good word. And anybody who thinks that the competitors are not allied amongst—that is, their, particularly their government and their industry, is not up to date on where the world economy is going.

So I think we do have a major issue of big, bold, far-reaching science, theoretical science, tempered with perhaps—or our budgets at the Federal level tempered with these kinds of team approaches which are collaborative in nature. The decisions are made—and I think this is important. The decisions are made by the teams of individuals themselves, and we are largely driving the process through private sector views of the problems and private sector decisions.

I think this is important, too. The Federal R&D economy is extraordinarily large, and a very limited, limited portion—I mean if you take big science, if you take big defense, if you take the academic input to the steering of the process, the private sector has a very limited role to play up to the present and probably should play a somewhat larger role. I think these kind of projects are very germane to that process, and hopefully our committee will help to make that happen.

Mr. WALGREN. Thank you, Mr. Ritter.

Mr. RITTER. I know that sounds like a speech, but I think it's important to put this on the line considering the kind of debate that one gets in around here. This is not an ideological question; it's a pragmatic question of being No. 1 and how do you get there? You don't get there by being adversaries. You don't get there by repeating other people's work. You don't get there by keeping the private sector out of the steering mechanism of the Federal Government's research initiatives.

Thank you, Mr. Chairman.

Mr. WALGREN. Thank you, Mr. Ritter.

The Chair recognizes Mr. Lundine.

Mr. LUNDINE. Thank you, Mr. Chairman.

I must say to my colleague from Pennsylvania I was distracted for a moment there and when my attention span came back, I did think that I was in the Senate. I would not accuse him of——

[Laughter.]

Mr. LUNDINE. I would not accuse him of making a speech, but I thought I might have been on the other side of the Capitol.

Mr. RITTER. Excuse me. If I could ask my colleague to yield.

Pennsylvania has two remarkably capable Senators and I am too modest to try and——

Mr. LUNDINE. I am not going to continue this dialog at all. I'm taking back my time.

Mr. WALGREN. And I think in fairness Pennsylvania has two Representatives on this committee, both of which can be accused of making speeches from time to time. [Laughter.]

Mr. RITTER. Thank you, Mr. Chairman.

Mr. LUNDINE. Dr. Leonard, I want to compliment you and your institute on the collaboration, as well as Dr. Keyworth, on the collaboration you have ongoing. When this subcommittee begins its markup of what is titled the Stevenson-Wydler Act, I intend to try to put forth a more ambitious program of collaboration between industry and our National Labs on technology development.

I was wondering listening to your testimony whether you've learned certain principles about that collaboration that through your own collaborative venture might be instructive for us in trying to develop better application of what's going on at our Federal labs.

Dr. LEONARD. Yes; I understand your question, Mr. Lundine. Let me first say that in my career I have spent some time at National Laboratories. I've also been in the academic world, as well as in industry. So I've had occasion to ask myself that same question. What I've learned is that a spontaneous upwelling of cooperation will be recognized by all parties, and when that occurs that's the thing to fund.

I think we have that here. And some measures of it are, first of all, funds coming from a variety of sources: Government, industry, private foundations, universities, wherever. We see a coming together of funds; that's an indicator that there is commitment.

Second, there is an upwelling—I guess that's Mr. Ritter's word, but I'll use it—of cooperation which is very apparent among the parties involved and begins to be apparent to others through specific programs. When the rhetoric is large and the program plans are small, watch out. The other way around is where it's important, when the program plans are substantive and there is, therefore, little need for rhetoric. And again, I think that is occurring at this place.

In summary, you let the folks who know what they are doing talk it over first, come up with a program and then funding will occur. I'm a firm believer of that. And that, I believe, is the case here.

Mr. **Lundine**. I think that's very useful. Thank you very much.

Dr. **Berry**. Mr. Lundine.

Mr. **Lundine**. Yes?

Dr. **Berry**. I wonder if I could amplify that a little bit, generalize it. I think if you're going to address this issue in the large, there has been a very important reexamination going on in the last 3 years of the role of National Laboratories. Particularly reexamining whether in the years previous, the National Laboratories had been directed to do a number of things, many things, that fall more properly in this sphere of industrial research and development. There was a lot of things that were going on in National Labs that they didn't want, that industry didn't feel they should be doing, in effect, many of which amounted to funding losers because someone had done exactly the opposite of what Dr. Leonard had just said. That is, someone had thought they knew better than the experts in the field.

Mr. **Lundine**. Presumably someone that sits on this side of the aisle.

Mr. **Ritter**. I said nothing. [Laughter.]

Dr. **Berry**. But there is a tendency I think to feel that because you are responsible for the funding that you also somehow have a substantive knowledge, which is an illusion. One has to have trust in fields like this or nothing happens. I think that one of the cornerstones of a program if you want to build one is precisely this point: that you must give the engineers and scientists the sense, or the responsibility, for the substantive development of their subjects, let them tell where they think the real advantage will come.

You will run into some problems. Not of scientific substance, but you will run into some problems. Problems of antitrust with collaboration sometimes, and that's something that you'll have to face.

Mr. **Lundine**. Mr. Seitz.

Dr. **Seitz**. There's one point that might be made as an add-on to things that have been said. There's a tendency in many of our basic industries today to enter into collaboration with other countries. General Electric, for example, manufactures the engine for the Airbus. In that case, it's obviously an advantage to us, granting that Airbus competition is probably here to stay. If we are to enter into favorable arrangements, such a partnership, it's absolutely essential that our country maintain its technological lead. Otherwise, it won't even be able to do that.

It's not merely a question of us against the world. It's a question of being able to play a role in the large technological world commensurate with our capacity.

Mr. **Lundine**. That leads me to my other question. Dr. Prindle, we sit around here debating whether we're going to pick winners or losers and, meanwhile, my impression is we're losing. I don't know if you had a chance to see the Washington Post article on ceramics back in February, but it made the point, as I guess you have, that the U.S. world market share is declining and particularly in semiconductor packages and other advanced products.

Does the program between NBS and the American Ceramics Society address this advanced ceramics on the point of our declining competitiveness?

Dr. **Prindle**. In an indirect sense it does address this point. And I am pleased to be able to add to Congressman Ritter's statement that ceramists also understand phase diagrams, besides metallurgists. This is a parallel program to the one that the American Society for Metals has with the Bureau. This is a counterpart with the American Ceramics Society to put phase diagrams into the 20th century; in other words, to use computer techniques.

Again, Dr. Berry alluded to this earlier in his testimony. This is a modern way to treat this kind of information. As such, it gives a data base that's much more accessible to scientists and engineers throughout American industry. So it's a supporting activity which helps our competitive position.

It's not going to solve the problems of competitiveness by itself, as there are many other aspects. They are very complex problems, as you're aware. But I think this kind of thing is a must. Not to carry out this sort of underlying coordination activity makes everything else very difficult to accomplish.

I think the offshore threat competitive aspect is sometimes exaggerated. I think American science still is paramount in many of these areas. I think many of the research discoveries are being made in American laboratories, both in universities and in industry, and in Government laboratories. However, the exploitation of this information is where we're falling down. We're simply not acting quickly enough to convert this knowledge into products, and that's where some of our foreign competitors are beating us.

Mr. **Lundine**. Thank you, Mr. Chairman. I ask unanimous consent to insert this article into the record.

Mr. **Walgren**. Without objection.

[The Washington Post article follows:]

[From the Washington Post, Feb. 10, 1985]

CERAMICS: OLD TECHNOLOGY, NEW USES

KYOCERA CORP. LEADS JAPANESE BATTLE WITH U.S. COMPANIES FOR MARKET SHARE

(By Mark Potts)

SAN DIEGO.—Ceramics, one of the world's oldest technologies, is the basis for one of the newest Japanese-American business rivalries. And so far, the Japanese are way ahead.

Kyocera Corp., an aggressive—some competitors say arrogant—Kyoto-based outfit with 2,000 workers in plants in the United States, has carved out 70 percent of the fastest growing part of the technical ceramics market, the manufacture of waferlike ceramic packages used to carry high-quality electronic chips in a variety of military and commercial applications. And the company also is gobbling up huge portions of what ultimately may be a more lucrative market: the use of "structural" ceramics to make such diverse products as scissors, artificial human joints and automobile engines.

But this is not necessarily another story of the United States losing a market to the wily Japanese—although that has been the case so far. American companies are entering the industry in droves, and experts say that, although the Japanese may have a sales advantage, they don't seem to hold any technical edge. "Can we catch up? I think so," said Gary Carlsson, head of the ceramics division of General Electric Co., one of the biggest American entrants in the race.

Ceramics—the time honored technique of molding earth into shapes and then firing them into hard finished products ranging from tea cups to toilet bowls—currently is a technological hotbed, and experts predict that the current $4 billion world market for technical and industrial ceramics could increase to many times that size by the turn of the century.

That optimism is based on a number of assumptions, however. One is that the market for ceramic semiconductor packages stays strong—no sure bet it, there's any weakness in the semiconductor industry. Another is that ceramics makers can overcome fears and misconceptions about the sometimes delicate physical properties of ceramics to make them widely accepted for such critical applications as jet engine turbine blades

A third assumption is that the manufacturers can prove that ceramics have enough value to become standard for big-ticket items such as automobile engines—something that seemed imminent a couple of years ago, but now looks years away.

Although ceramics have been around for a long time, the modern industrial ceramics industry is only about a quarter-century old—just about exactly the age of Kyocera, by no small coincidence.

Kyocera founder Kazuo Inamori didn't invent the technology his company was built on, but he was apparently one of the first to realize that ceramics produced from sand and chemicals rather than clay could be used to protect electronic circuits. The ceramic packages offer excellent electrical insulation, superb dissipation of heat and other properties that make them superior to the plastic packages used for less-critical semiconductors.

With a devotion to service and customer relations—and inadvertent help from oldline ceramics companies that apparently didn't see the opportunity—Kyocera cornered the market. "They kept investing and driving the price down. Everybody else stood and watched," Carlsson said, while Richard Spriggs, president of the American Ceramics Society, and that American ceramics companies "somehow were asleep at the switch and failed to see the market develop."

Kyocera officials modestly say market domination wasn't their goal. "Kyocera doesn't have such an intention to dominate the market," said Keisuke Hasegawa, president of the company's San Diego-based American arm, Kyocera International Inc. But that's how things evolved, and last year Kyocera reaped $1.1 billion in sales and a nearly 50 percent increase in profit.

Because semiconductor types vary so radically, electronics packaging is largely a custom business, despite its size—$1 billion a year and growing fast, Kyocera and its competitors make the packages in small quantities to exacting customer specifications. "You can't set up a production line and run a factory off it," said William L. Everitt, Kyocera's vice president for corporate communications, who likens the process to running "a job shop."

Carlsson agrees that customer service is the key to the ceramics business, and he has been working to build that as well as technology for GE's ceramics division, which the company purchased from 3M 16 months ago. "It will be, in our opinion, a very custom world," he said. "It's the service element of this thing, when you're talking custom, that makes this business."

Doing that requires keeping in close touch with customer needs, something Kyocera prides itself on. "Kyocera is very lucky to maintain this service attitude to the customer," Hasegawa said.

But competitors see it a little differently. "They have a catalogue of technology," Carlsson said, charging that Kyocera often forces customers to take one of the company's 200 or so generic designs rather than wait for a more customized version. Other experts also suggest that Kyocera, in the time-honored Japanese business tradition, has kept prices artificially low to drive out competition and increase market share, something Kyocera denies.

GE is one of several American companies endeavoring to catch up to Kyocera. Others include E.I. du Pont de Nemours & Co. Inc., Coors Porcelain Co. (an affiliate of the brewer) and Norton Co. International Business Machines Corp. is also a major maker of ceramic packages, but only for its own, considerable, use. In many cases, U.S. companies have joined forces with Japanese companies to enter the industry. There may be plenty of business to go around. "If you believe the . . . forecasts, there's a very large market there for a number of good-sized companies," Carlsson said.

But attactive though the ceramic electronic-packaging market is, it still carries risks! It's vulnerable to slumps in the slumps in the semiconductor industry, loses a good deal of business to the cheaper but less efficient plastics packages, and eventually may fall victim to competitive saturation.

So the big players in it are already diversifying. Carlsson has begun to tap into the plastics know-how elsewhere in GE, and Kyocera, along with everybody else, is pushing forward into what potentially could be an even larger market: structural ceramics.

Ideally, these large-scale ceramics products could end up as replacements for all sorts of metal parts in industry, offering their superior temperature, friction and wear capabilities. But the market has been slow to develop. "One of the problems is that people think, here is a mental part, we'll make it out of ceramics, we'll drop it in, and life will be glorious," Carlsson said. "Problem is, most of the time it won't work.

One of the big reasons for that is the property of ceramics that at times can outweigh all the other advantages: brittleness. Drop a finely made ceramic part on the floor, and it can shatter like a teacup. This isn't much of a problem in electronics applications, but it has hampered ceramics' acceptance in a number of areas.

Jet-engine makers, for instance, are reluctant to make turbine blades out of ceramics. While the impending failure of a metal blade can be detected and the part replaced, ceramics blades tend to fail all at once—destroying the engine. As a result, many in the ceramics industry believe it will take decades of development of stronger ceramics before blades made of the material become regular equipment in passenger jet engines--though they will find their way pretty soon onto unmanned jet aircraft such as cruise missiles.

But the hold grail for the structural ceramics industry is the ceramic automobile engine, a potential showcase for all of the advantages of ceramics—but currently an excellent illustration of most of the problems with ceramic parts.

A ceramic engine—more likely a diesel or gas-turbine engine than gasoline-powered, for various technical reasons—would be lighter, cooler and more-fuel-efficient than a metal engine. It would not need a cooling system, saving weight and power, and would require little lubrication. That's the good news.

The bad news is that it could be a lot more expensive than an equivalent metal engine. Therefore, makers of such an engine would have to prove that the other advantages outweighed the costs. And so far, with fuel prices relatively low, they haven't.

"What was ceramics fever in the U.S. market a few years ago has abated, along with the oil prices," Carlson said. Auto makers and ceramics manufacturers have cut back on their ceramics-engine programs, and even Kyocera—which upon unveiling the world's first ceramics diesel engine in 1983 predicted it would be available to the public by 1990—now places the target a few years farther off. Durability of the ceramic engine under stress also remains a question.

Still, Spriggs said the ceramic engine "is a big pot of gold at the end of the rainbow. . . . You're looking at a market 20 years out that dwarfs the existing market today." In the meantime, ceramics makers are developing ceramic parts for use in metal engines, including pistons, valves and cylinder sleeves, and some experts believe the ceramics engine thus could evolve rather than arrive all at once.

Kyocera also is insinuating its ceramic products into other areas of life, particularly in Japan. The company is making and selling ceramic golf putters, ballpoint pen tips, scissors and sushi knives, both to increase consumer awareness of ceramics and to gain technological expertise.

To hedge its bets further Kyocera has been diversifying of late: Its products include KLH audio equipment, Yashica cameras, and the popular lap-model computers it makes for Radio Shack and other companies.

But Kyocera and others in the ceramics industry believe that, given time and technology, ceramics will become one of the world's major materials—and a huge industry, with plenty of room for competitors from many nations.

"I think it's coming inexorably," Spriggs said. "All of the areas of ceramics of the high-technology type seem to be able to sustain high growth rates for the foreseeable future."

"Acceptance is accelerating around the world," Everitt said. "We think it's going to become almost a revolution when the acceptance factor hits a certain level. The applications are going to be almost unlimited."

Mr. **Walgren**. Well, on behalf of the committee let me express our appreciation for your contributions today. We found them very helpful and interesting, and we hope we can pick up on some of the threads and leads that you've given us.

Thank you.

Let me call the second panel today made up of several different kinds of interest: Dr. Gordon Millar, the former vice president of engineering with John Deere & Co.; Mr. Paul Fitzgerald with Factory Mutual Research Corp.; and Dr. Jordan Baruch, who has been with us before.

STATEMENTS OF GORDON H. MILLAR, PH.D., FORMER VICE PRESIDENT OF ENGINEERING, JOHN DEERE & CO., MOLINE, IL; PAUL FITZGERALD, FACTORY MUTUAL RESEARCH CORP., NORWOOD, MA; JORDAN J. BARUCH, SC.D., WASHINGTON, DC

Dr. **Baruch**. Mr. Chairman, is it OK if we take 3 minutes before you start?

Mr. **Walgren**. Sure. In fact, we're going to start with Dr. Millar. Feel free to join us when you get back.

[Pause.]

Mr. **Walgren**. All right, well, let us proceed. Dr. Millar, welcome to the committee. As I said at the beginning, written statements will be reproduced and included in the record for everyone's review both the committee members' and the public's review, so please feel free to outline the points which you feel you'd really like to underscore.

Dr. **Millar**. Well, Mr. Chairman, and members of the subcommittee, I'm really here representing industry in the manufacturing sector, and I also chair the panel under the National Research Council that looks at the programs of the National Engineering Laboratory, a subset of the National Bureau of Standards; and from both points of view we support very strongly the activities of the Bureau and urge that adequate funding be provided to carry out their activities.

In particular, I was asked to address the issue of robots and robotics and how the Bureau fits into development of that technology and how their automatic manufacturing research facility is looked upon from an industry standpoint.

I think it's not difficult to examine that issue because robotics is enormously important to our maintaining or regaining competitiveness in the manufacturing world. In listening to the previous panel discussers, it's quite clear that we have to deal with the issue of competitiveness, but I think we also have to think about how we define it. Because it is one thing to look at competitiveness as it existed 20 or 30 years ago where the North American Continent was essentially our market, and now if you, in the manufacturing sense if you don't look at the global markets, in effect, you're really sooner or later going to be out of business.

And so sharing that kind of information and development of the standards such as IGES and MAP, which is the graphics exchange standard for computers and the manufacturing automation protocols, those kind of things which come out of the manufacturing research facility of the Bureau are enormously important to putting in place the kinds of manufacturing activities in our traditional industries which we must necessarily put in place in order to be competitive.

That essentially summarizes what my statement says. I think probably rather than going through and picking any other bits and pieces that you might want to, by my choice I would much rather respond to questions so that I can elaborate in areas that need elaboration of your choice rather than mine. So although that's a brief statement it's documented well I think, as well as submitting a portion of the report which was included as parts of the written presentation.

One other item. The entire report is available, and it's simply called "Evaluation Report, National Engineering Laboratories." It's a current report and available for anyone who wants to get a copy of it and read it, and it pretty well summarizes and documents the results of the panel which I chaired.

[The prepared statement of Dr. Millar folows:]

GORDON H. MILLAR

3705 39TH STREET COURT, MOLINE, ILLINOIS 61265

3 March, 1985

Tel No 309/797-4487

The Honorable Doug Walgren, Chairman
Subcommittee on Science, Research
and Technology
Committee on Science and Technology
U. S. House of Representatives
Washington, D. C., 20515

Mr. Chairman and Members of the Subcommittee
on Science and Technology:

I am Gordon H. Millar, recently retired Vice President of Engineering for Deere and Company in Moline, Illinois. I am here to testify on behalf of the National Bureau of Standards and to support the Administration's budget proposal of $120,000,000 for the National Bureau of Standards for fiscal 1986.

During the past several years I have served as a member and now Chairman of the National Research Council's National Engineering Laboratory Evaluation Panel and as its Chairman a member of the Board of Assessment of the National Bureau of Standards programs.

I am including as part of this testimony the first three pages of my report on the National Bureau of Standards National Engineering Laboratory published in 1984. The complete report is available from the Board on Assessment of NBS programs, 2101 Constitution Avenue, NW, Washington D. C. 20418.

The excerpts from the complete report generally characterize my view supported by members of the Evaluation Panel and endorsed by the National Research Council of the worth and contribution made by the National Engineering Laboratory of the National Bureau of Standards. Of principal concern to all of us in industry is the work of NEL in supporting, advancing and coordinating modern manufacturing technology in the United States. This work is principally carried out in the NEL Center for Manufacturing Engineering which is the source of the ideas, resources and personnel for their experimental automated manufacturing research facility (AMRF).

The AMRF is a modern experimental manufacturing laboratory which includes a number of robotic systems and is the experimental laboratory for the development of computer-based manufacturing techniques. It is also the source for the development of automated manufacturing standards such as IGES and MAP, which are the means by which computer-based manufacturing centers may communicate with each other in an accurate real time mode. IGES stands for the Initial Graphics Exchange Specifications and MAP for Manufacturing Automation Protocols. IGES is the basis for the computer exchange of graphics information; MAP is the means by which written specifications including numerical quantification can be exchanged between work stations from work stations to a data control base and through it to a manufacturing facility wherever the information is needed.

The National Bureau of Standards represents a unique resource which is very much needed by our manufacturing industry today, not only as a source of metrology standards, but as an advanced research facility focused on the improvement of manufacturing procedures in commerce and industry.

From my close association with the National Bureau of Standards and the National Engineering Laboratory for the past several years I am convinced it is a well managed, highly disciplined and professionally competent facility. It serves a scientific and engineering role that cannot be duplicated in private industry. It occupies the unique position of serving the broad spectrum of the United States Manufacturing Commerce and provides a national resource to support the advancement of manufacturing in the private sector.

My special role in this hearing today is to address the question of robots and robotics of the National Engineering Laboratory, In taking this position I do not suggest in any way that other activities of the Bureau are less important. On the contrary, with few exceptions the Bureau has served our nation well for over 80 years and has done so in a cost-effective and productive manner.

The issue of robotics is one that is going through enormous change with very rapid growth and expansion. Robotics serve the role of improving and making more competitive our United States manufacturing businesses. Robotics serve the purpose of improving the workplace by doing hazardous, uncomfortable or totally repetitive manufacturing operations. They enhance the domestic workplace and provide a new range of job opportunities for workers trained in their maintenance, repair and programming.

Robotics today, however, suffer from the fact that they are basically memory units and have acquired only a very limited sense of vision, touch and voice recognition. For robotics to really meet their expected contribution, a great deal of work must be done to convert robotics practice from pre-programming memory-driven robots to those with some sense of vision and touch which, when combined with the memory programs now available, begins to lay the groundwork for developing robotics with some level of artificial intelligence.

It is this latter work that is so important to our nation which I believe can effectively be carried out in the National Engineering Laboratory of the National Bureau of Standards. For our nation to regain the competitive posture we once enjoyed in world markets, it is absolutely essential that we raise the efficiency of our manufacturing activities, reduce the cost of our products in world markets and develop a flexibility of manufacturing that will meet customer expectations for quality and performance unmatched by any current manufacturing effort. To do this it is necessary to develop basic standards of computer application which I mentioned earlier in this testimony. This is the kind of activity, which in my judgment, is well within the charter of the National Bureau of Standards, and in both the short and long range has enormous scientific and technical leverage when properly supported and made available to the manufacturing organizations of our country.

The entire report of the Panel I chaired is available as I mentioned earlier from the Board on Assessment of the National Bureau of Standards programs or directly from the National Research Council. I would urge each member of the Subcommittee to at least glance through the report, get some feel for the depth and effort made by both the Evaluation Panel and the Board on Assessment of the National Bureau of Standards programs as a basis for judging the performance of the Bureau. Obviously, any operation can be improved, and the report contains some suggestions for improvement. In general, however, it is my opinion supported by other members of my Committee that the National Engineering Laboratory completely meets its charter, is a unique and valuable resource and should be funded at the level requested by the Administration.

GORDON H. MILLAR
Moline, Illinois

GHM/vmm

AN EVALUATIVE REPORT ON THE NATIONAL ENGINEERING LABORATORY

Panel Members

Gordon Millar, Deere & Company, Chairman
Wilmer R. Bottoms, Varian Associates
  Chairman, Panel for Electronics and Electrical Engineering
George E. Dieter, University of Maryland
Robert C. Doban, Owens-Corning Fiberglas
  Chairman, Panel for Building Technology
Harold W. Kuhn, Princeton University
  Chairman, Panel for Applied Mathematics
Richard S. Magee, Stevens Institute of Technology
  Chairman, Panel for Fire Research
John S. Sobolewski, University of Washington
  Chairman, Panel for NBS Computing
William B. Street, Cornell University
  Chairman, Panel for Chemical Engineering

Unable to Attend

John G. Bollinger, University of Wisconsin-Madison
  Chairman, Panel for Manufacturing Engineering
Alan Schriesheim, Argonne National Laboratory

Invited Participant

Erwin G. Loewen, Bausch & Lomb, Inc.
  Member, Panel for Manufacturing Engineering

This report, submitted by the Chairman, Gordon H. Millar, covers the activities of the National Engineering Laboratory during the 12 months preceding the Panel meeting on April 12-13, 1984.

Functions of the Laboratory

The National Engineering Laboratory (NEL), a major organizational unit of the National Bureau of Standards (NBS), provides the public and private sectors with improved measurement technology and data services that address national needs.
The Laboratory's work includes engineering measurements and data, test methods and proposed engineering standards, and new engineering practices. The Laboratory conducts research in engineering and applied sciences and builds and maintains competences in the scientific disciplines required to carry out this research. Major program goals of the Laboratory include improving statistical, computational, and mathematical modeling methods for use in engineering and science research; advancing measurement capabilities for electromagnetics, electronics, and semiconductor technology; developing metrology and engineering standards for computer-aided design, manufacturing, and inspection; improving measurements for chemical engineers; improving the cost-effectiveness of buildings through better

codes and standards; and reducing losses from unwanted fires.

During fiscal year 1984, the Laboratory had a staff of about 1068 and a total operating budget of approximately $76 million.

Chairman's Overview

The National Engineering Laboratory of the National Bureau of Standards represents a scientifically sound, industrially oriented resource that is of enormous value to both the government of the United States and private industry. The six separate centers plus computing cover major activities in areas of engineering in which NBS has developed substantial expertise. Summaries of the reports documenting the activities of these seven units are included with this report; it should be noted that the technical areas covered are not replicated any other place within the federal government or in private industry. On this basis alone NEL represents a unique activity that should be supported at the highest funding level consistent with allowing our nation to compete effectively in world markets.

There are several issues that cut across center organizational lines that the NEL Panel believes should be addressed. These are discussed in the following paragraphs.

National Engineering Laboratory Mission Statement

There is apparently some feeling in the Congress and the Office of Management and Budget that NEL and its associated programs are not completely within the current NBS charter. The Panel believes that the work of NEL is an expansion of the NBS mission but not outside the intended area of effort. It is important, however, to make sure that as the NEL pursues its unique effort, the NBS mission statement be revised to recognize the expanding role of engineering research and practice in the United States. This mission restatement may best be accomplished through legislativ effort resulting in a revised NBS charte

Engineering Data Base

There is a need in our country to establish a single comprehensive engineering data base in order to make information standards, physical properties, and othe types of information available to engineering practitioners that authoritatively represents the latest in engineering and scientific understanding that is readily available in usable form. It is the Panel's judgment that NBS and in p ticular NEL is the proper repository for this activity. The Panel further believes that NEL should take positive action to examine the architecture of suc a system and to recommend to the dire of both the NEL and NBS what steps sh be taken to implement this activity.

Technology Transfer

A great deal of concern has been expressed in various departments of the federal government that the defense m anism of our country is in some way cor promised by the continued free exchang of scientific and engineering informatic between segments of our federal goverr ment and private industry and between nation and its foreign collaborators. The Panel believes that nothing could b further from the truth. The history of mankind's growth documents that the greatest advancement of scientific tecl nological and social systems takes plac in an environment of mutual scientific exchange. Once the freedom to commu cate is hampered and censorship in any form is imposed, there exists the risk that the resulting isolation will lead to a skewed intellectual understanding of the scientific and engineering world tha will obscure and hinder engineering growth. Certain classes of information that relate to our nation's defense posture must necessarily be classified, but the Panel believes that blocking the exchange of engineering and scientific data is detrimental and recommends that any action in this direction from any quarter be resisted.

Funding

The Panel believes that the Centers for Building Technology (CBT) and Fire Research are appropriate for NBS. However, the year-to-year funding uncertainties of these two centers make it difficult to maintain a high-quality program and have adversely affected morale and productivity in CBT. Some degree of stability must be assured. In fact, the Panel believes that, in general, too much NEL staff time is spent on the annual budget process.

The Panel agrees with the Packard Committee report (Report of the White House Science Council, May 1983) that a multiyear funding cycle for NBS would be beneficial.

Industrial Grants

The Panel notes that some people at NBS are of the opinion that NBS cannot or should not accept research grants from industry even though such grants have been approved. The Panel believes that industrial grants can provide welcome funds and good interactions with industry.

Upgrading of Staff

The Panel in general is pleased with the competence profile of the general staff of NEL. For example, over 40 percent of the professional staff have PhDs, some 25 percent have master's degrees, and another 25 percent have bachelor's degrees. Less than 5 percent of the professional staff have no recorded degree credentials. It is also recognized, however, that continuing education, particularly of the key scientific and engineering disciplines, is absolutely essential for maintaining the health and vitality of any engineering laboratory. To this end, the Panel strongly recommends that continuing education of NEL staff members be given a higher priority than it now appears to have. It is suggested that exchange programs be developed with both industry and universities and that staff members be made aware of the need and the requirement for their skills to be continually upgraded through training, adjunct experience, and other educational activities.

GORDON H. MILLAR

Vice President, Engineering (Retired)
Deere and Company, Moline Illinois

Gordon H. Millar is a Mechanical Engineering graduate of the University of Detroit with a PhD in Mechanical Engineering from the University of Wisconsin. He holds honorary Doctorates from the University of Detroit and West Coast University. Dr. Millar joined Deere and Company in 1963 as Director of Research and established the Deere and Company Technical Center. He served asAssistant General Manger of John Deere Tractor Works in Waterloo, Iowa, and worked two years on special assignment in Europe. Dr. Millar retired from Deere and Company as Vice President, Engineering in December, 1984.

Before joining Deere and Company, Dr. Millar worked for the Ford Motor Company, Meriam Instrument Company and McCulloch Corporation. While at McCulloch, he developed a lean oil mix and surface gap ignition system for outboard motors which is the industry standard today. He has worked closely with the National Aeronautic and Space Administration to increase involvement of private enterprise in cooperative research with NASA. Deere and Company signed the first Technical Exchange Agreement with NASA for such research. He has presented Congressional Testimony on space and science applications.

Dr. Millar is active in educational leadership, on both the local and national levels. Besides a current teaching assignment at St. Ambrose College, he serves in a variety of educational policy-making positions. He is currently President of the Accreditation Board for Engineering and Technology, which is the national accrediting agency for schools of engineering. He is on the College of Engineering Advisory Boards for the University of Detroit and the University of Illinois. He is a founding member of the Bradley University College of Engineering and Technology Advisory Council. He served as Chairman of the Board of Regents in Illinois until 1971.

Gordon Millar is active in a wide range of professional organizations. This includes the Society of Automotive Engineers in which he is a Fellow Member, a member of the Board of Directors and served as President in 1984. He is a member of the National Academy of Engineering, the American Society of Mechanical Engineers, the National Society of Professional Engineers, the New York Academy of Sciences, and the College of Fellows of the Engineering Society of Detroit.

Dr. Millar serves on the Board on Army Science and Technology of the National Research Council. He is Chairman of the National Engineering Laboratory Evaluation Panel of the National Bureau of Standards and is Past Chairman of the West Central Illinois Telecommunications Corporation. He has seven patents and is the author of many technical papers. He is a licensed commercial pilot and is active in several aviation organizations.

Mr. **Walgren**. OK, fine.

Well, thank you very much. We'll come back to you with some discussion, and that's certainly a very adequate presentation for our purposes. That, along with the written statement will be a good base for trying to appreciate the views and areas that you have close contact with.

Let me then turn to Mr. Fitzgerald.

Mr. **Fitzgerald**. Thank you, Mr. Chairman.

On behalf of Factory Mutual Research and myself I thank you for your invitation to be here today.

I've come to address the issue of the proposed elimination of the Center for Fire Research within the National Bureau of Standards. I'd like to highlight what I see as being the three major issues I see associated with this proposal.

They are, first of all, the Center represents a very unique facility in the United States, and perhaps even the world. It is, in fact, the only facility I'm aware of which is involved—engaged in long-range research aimed specifically at reducing the tragic loss of life from fire in the Nation. It's also the only laboratory, including our own, which doesn't have any bias as it attacks a given problem.

The second issue deals with the representation that, or the assumption that State and local governments or the private sector will pick up the Center's work. I know of absolutely no basis for drawing that conclusion. However, it is a fact that private sector initiatives such as ours will be seriously impaired if the Center is lost. I can say that on the basis of past history. Our program had its origin back in the midsixties when we engaged in some joint research programs with the National Bureau of Standards, and we are today the major private sector research organization in the country investigating fire and fire-related problems.

If the Center is lost, certainly any progress is going to be set back many, many years. Without the support the Center also gives to the universities in this Nation, I fear that the future supply of fire research scientists will also become very limited; and that, to my view, is a very crucial part of the role that the CFR plays in the long-term improvement of our fire record in this Nation.

The third topic really deals I think with the results that the Center has been able to accomplish in its history. I happen to view it as a very, very successful organization. Further, their current programs, which we happen to be following very closely, and the initiatives they've taken, such as the formation of a group to develop a national fire research strategy, promise even more progress in the near future.

I think of particular interest in this regard has been the historic ability of the Center's staff to work and to stimulate private sector programs such as ours.

In a nutshell, I think that is the summary of the statement that I submitted to the committee, and those are the three major points that I see associated with it. However, in response to the committee I was also asked to provide some comments on what we see the role of the CFR vis-a-vis the U.S. Fire Administration and I would like to append a few comments in that regard.

In our view both the Center for Fire Research and the Fire Administration have very specific priorities all of which are mutually supportive. Historically, the Center has developed the basic information dealing with the chemistry and physics of fire, and has very recently begun the very difficult task of developing computer models which in the end will greatly improve the overall cost effectiveness of fire research programs, code enforcement, engineering and the like.

The USFA approach has been much more direct and geared to the short-term solution. They have—their role has largely been to take and refine existing technology and aggressively attack the most pressing of the Nation's problems, the residential life safety problem. As an example of that is the residential sprinkler development program which began in the late seventies and was concluded a few years later. Certainly this program, which was conducted under USFA leadership is one of the great advances of fire protection in this country. What's not generally known is the fact that the original pioneering work in this area—I guess you could say the work that made the later program possible—was done by the Center for Fire Research. USFA took those results and, in a very short period of time, turned the technical concept into reality.

A little bit of insight on that. We are now spinning off this technology in the area in which we devote the majority of our fire research and extending it to industrial and commercial occupancies. In our view, this is an example of a well-structured approach to Federal fire research. In a sense the interrelationship between the Center for Fire Research and the USFA. is very similar to our own organizational setup. Besides fire scientists, we have applied researchers and engineers whose role it is is to complete, that is to say materialize, the research and transfer it to the practitioners. One particular advantage of this is that it creates the channels that promote feedback for the research. So in response to the direct question, I don't see the USFA role in any way in conflict with the role of the Center; there is no duplication. As it is now, we believe that the Government has the proper mechanism to develop, materialize, and transfer research results for the private sector and to society at large, and would strongly advocate maintaining the existing structure.

[The prepared statement of Mr. Fitzgerald follows:]

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Paul M. Fitzgerald
Vice President and Chief Operating Officer

March 1, 1985

U. S. House of Representatives
Committee on Science and Technology
Subcommittee on Science, Research and Technology
Washington, D.C.

Attention: The Honorable Doug Walgren, Chairman

Subject: NBS Center for Fire Research

Honorable Committee Members:

As we understand it, the budget proposal to the Congress for Fiscal Year 1986 would eliminate the National Bureau of Standards Center for Fire Research (CFR), thus reducing the budget by $5.1 million. The expectation is that private sector and possibly state and local governments will increase their support of fire research.

To our knowledge, state and local governments have never supported long-range fire research on a broad, on-going basis. In our opinion, the chances of such support developing in the future is extremely remote. The fire problems faced by state and local governments tend to be centered around the immediate needs occasioned by code enforcement or provision of community fire fighting resources. Their attempts to deal with the problems of today already strain their resources. They will not be able to divert resources to research which may provide cost effective, technically sound solutions to problems some years hence.

The group of mutual insurance companies comprising the Factory Mutual System is, through the Factory Mutual Research Corporation (FMRC), the principal private-sector supporter of fire research in the nation. We spend over $3,000,000 annually to support an internal program for fire research and improvement of fire protection standards. To our knowledge, other insurance organizations do not support fire research to any significant extent. About 80% of our own internally funded research is aimed primarily at improved protection of industrial and commercial properties ("highly protected risks"). The remaining 20% of our internally funded research is more long-range, or basic, in nature, and could be applicable to fires which threaten either life or property. The allocation of our own resources illustrate another facet of private sector investment in fire research - namely, that businesses can only afford to expend funds for research that will directly benefit them. As such, their efforts are likely to have a very narrow focus which may not directly bear on national priorities.

We estimate that about two-thirds of the nation's long-range fire research effort is supported by the CFR. The remainder is supported by other federal agencies and by ourselves. The focus of the CFR's research is aimed primarily at the life-threatening aspects of fires-primarily residential fires. Thus, the work of the CFR is unique and directed toward the most pressing of the nation's fire problems - the loss of human life.

The thrust of the CFR's technical approach has been toward developing models which will enable practitioners - i.e., engineers, code officials, fire departments, etc. - to make technically sound decisions about the fire hazards of buildings and their occupancies. Such models will also permit the development of realistic and cost effective test techniques which industry can use to evaluate new materials for such properties as their flammability and toxicity in fire scenarios. By developing such techniques, we believe it will be possible to substantially reduce future fire losses by introducing improved, less flammable materials both into the home and the workplace.

In addition to their own research, the CFR also plays a critical role in providing collaborative support to other research organizations such as ourselves. Through interaction with CFR scientists, I know our staff has been greatly assisted in their work. Through symposia and their fire information service - including the upcoming FIREDOC online data base - the CFR has been in the forefront of transmitting information and data to other research and educational institutions. Without the Center, our own program would be seriously impaired. Certainly, no single organization has the resources to duplicate the Center's and the loss of those resources would greatly diminish the output of all U.S. fire researchers.

Recently, the CFR has taken the lead in developing a national strategy for fire research that will encompass both the private sector and governmental community - university and resource groups, engineer, fire service professional, industry, etc. The National Fire Research Strategy Conference scheduled for July is an innovative joint project between the CFR and the private sector to better coordinate and identify the national needs and the ongoing independent programs which may address the key issues. Because the CFR is the only major fire research organization of any size with no proprietary constraints or bias, they are the only group which can effectively coordinate such a strategy.

Also of particular importance is the CFR's role in maintaining effective liaison with fire research efforts in the rest of the world. Their success in this area is demonstrated by their hosting the largest international fire safety science symposium ever held in October. Certainly a central coordinating body in the U.S. overlooking fire science research is necessary if improved scientific approaches to fire protection are to be realized. State and local governments and the private sector cannot fill this gap, especially in the area of international scientific exchange which clearly would benefit from the presence of a Federal Government agency.

For all of these reasons, we strongly urge your support for the continuation and expansion, if possible, of the Center for Fire Research. We believe that their performance demonstrates a high level of initiative and accomplishment. Much has been done but much more remains to be done. The loss of human life in the United States remains among the highest in the world. The importance of the Center's work in addressing this national need and the historical limited motivation of the private sector to duplicate their efforts indicates that Federal government involvement in fire research should be a national priority on a permanent basis.

Very truly yours,

Paul M. Fitzgerald

Paul M. Fitzgerald

PMF/rkc

BIOGRAPHICAL SKETCH

Paul M. Fitzgerald
Vice President and Chief Operating Officer
Factory Mutual Research Corporation

Born - Boston, Massachusetts
Graduate Chemical Engineer - Tufts University 1964
Master Business Administration - Babson University 1978
Joined Factory Mutual- June 1964
Previous Positions
- Special Hazards Engineer - FMRC
- Staff Engineer/Factory Mutual Engineering Association
- Manager Special Hazards Engineering - FMRC
- Manager B/M Standards Department - FMRC
- Chief Operating Officer - FMRC

Member National Fire Protection Association
Past Member Several NFPA Committees and
past Chairman Airport Facilities Committee
Registered Professional Engineer
Contributor to Fire Protection Literature

Mr. **Walgren**. Let's then go to Dr. Baruch, who has been here before. We don't mean to put you through your whole life passing before your eyes again. Dr. Baruch used to have responsibility for both the Office of Productivity, Technology, and Innovation and for the Bureau of Standards, as I understand it, at least administratively. We appreciate your being a resource to the committee, even though you are not now in direct Government service.

Dr. **Baruch**. Mr. Chairman, I thank you for those words. I hope that I will never leave Government service and hence. I appreciate the opportunity to testify here today.

Having listened to the earlier testimony, however, one of the things I'm sad about is that while the Congress can use its subpoena power to get the OMB here to testify, wouldn't it be wonderful if you could get them here to listen?

Mr. **Walgren**. There was a saying—there aren't that many people and we have a little time. I couldn't help but thinking how little we really do for each other in this society except perhaps in the defense area. I kept thinking of the refrain in some song from the sixties, and I don't know what song it was, but the expression was "The cops don't need you and, man, they expect the same." Oftentimes when we don't do anything for each other, I think we've fallen into that syndrome.

The thing that brings that to mind is there was another expression where a musician asked somebody if he was going to hear the concert tonight. The fellow said, "Oh, yes, I'm going to be there." The musician then said, "I know you're going to be there, but are you going to hear it?" So it may not make much difference whether OMB comes to these meetings or not because they wouldn't hear it anyway.

Well, I'm sorry for that diversion. Go ahead.

Dr. **Baruch**. I don't consider it a diversion, I thank you.

In my written testimony I've argued strongly for additional funding for three programs: The National Bureau of Standards the Fire Program, the Institute for Computer Sciences and Technology, and the Factory Automation Program. I'd like to make clear, however, that I've argued strongly for these programs primarily because they are examples that illustrate a major problem we now face in our budget dilemma.

Each of these programs, and many others in the National Bureau of Standards, as you heard today, are real investment programs and cannot, indeed they must not, be considered under the same budget-cutting rubric as the myriad of programs in which the Government simply spends its money without the promise of future return. As you know, much of my time is now spent advising members of industry on the management of technological innovation, one aspect of which is the evaluation of the economic worth of technological research and development programs, evaluations which generally have to be done not by scientists but by responsible managers.

In any rationally managed enterprise facing a scarcity of resources, investments, and expenses are kept separate. Expenses may be cut to the bone, whereas investments are individually evaluated, particularly for their ability to reduce future resource shortages, for their ability to show a profit.

Now, profit may be a strange concept in Government. It's certainly not considered by any OMB with which I've worked. Yet many NBS programs fall in that class and are underfunded. Incidentally, the definition I use for "underfunding" is simple. A program is underfunded if additional funding would increase its net present value by returning more than the investment would at the Government's cost of capital. Each of the programs that I've discussed has that ability. The ability to produce hard-cash returns that are significantly higher than the Government's cost of capital; in general, higher by many times that cost.

Now, despite the fact that these programs are thus compelling investments and each is underfunded, the OMB which characteristically fails to distinguish between investments and expense has directed that they be cut or at best held suffocatingly constant. It is an approach that I urge this committee to reverse.

But I would like to leave those Bureau programs for now and pay more attention to the administration's budget proposal for the Office of Productivity, Technology and Innovation [OPTI], the organization I once ran. OPTI, which was formerly the Office of Science and Technology at the Commerce Department, was renamed to make clear its strategic role. It was intended to provide strategic direction for the NBS, the Patent and Trademark Office, the National Technical Information Service, the Office of Product Standards, and several other line activities that reported to the Assistant Secretary.

In addition, its close contact with the best minds in industry and academia enabled it to provide detailed advice to the Secretary, the President's science adviser, and to the President on national policies that could act to promote world class innovation in our increasingly technological society. With a direct staff and others on loan from NBS and the PTO, totaling about 35, it did this job very well. For example, over 150 participants from industry joined it in doing a major domestic policy review on industrial innovation, many of whose recommendations were implemented either by the Carter administration or the Reagan administration.

Now, however, the administration proposes to abolish OPTI and thereby save a minute fraction of 1 percent of the Commerce Department's budget. As you said, "We ain't talking about real money." It's true that OMB has already damaged OPTI by removing the NBS and the Patent and Trademark Office from its umbrella, and hence removing the strategic supervision of those agencies that it could once exercise. It's true OMB has further damaged it by annually cutting back on its staff and budget.

Yet, despite this damage OPTI under the Reagan administration has been valuable. It has shepherded through the antitrust legislation that permits companies to work together on basic technologies. I'm sure you realize that that was a major effort. It has conceived and implemented a program on research and development limited partnerships. It's much too early yet to tell whether those will make a major contribution to our economic well-being, but at least the program is underway. And it has worked tirelessly in industry to encourage an understanding of the need for technical advance via sensitivity analysis and good managerial technique in industry. Indeed, it runs a program on sensitivity analysis training.

But you know, the biggest crippling of OPTI comes about because, like other executive department agencies, it is continuously constrained by OMB to testify inaccurately about what are appropriate innovation strategies for the government and the country. Indeed, Secretary Merrifield is now required to testify that OPTI's work is done. And, in the image of Jonestown, OPTI is constrained to propose its own suicide. A suicide that will damage all of us because it will deny to the country and to the Congress the help that we need.

Mr. Chairman, members of the committee, I believe that there is a need for the United States to have an effective office that can examine the range of scientific and technical activities of the Government and assess them as investments in our future. The need for that office is growing, not shrinking. So I'd like to urge you to continue the budget for OPTI undiminished through 1986, but during 1986 I'd like to leave you with a difficult thought and propose a difficult act. In the past, the Congress established the OTA [Office of Technology Assessment] primarily to examine and to assess the negative aspects of technology to prevent its proponents from destroying our culture and our future. It's a task that has grown in scope over the years.

I believe that it's now time for you, the Congress, to face the reverse, side of that coin and establish, as an instrument of the Congress, an Office of Technological Strategy. It must, of course, not have the simple-minded task of picking winners, but it should be an office that will work closely with the authorization and appropriation committees to identify specific projects and programs where government investment can show a profit and buy us a brighter tomorrow. History tells us that only the Congress can do it. Only the Congress has the persistence, the vision needed.

The only question that remains is whether the Congress has the will in these difficult times. I believe that it does. And in that belief, Mr. Chairman, members of the committee, I thank you again for your patience and the opportunity to testify here today.

[The prepared statement of Dr. Baruch follows:]

Testimony of Dr. Jordan J. Baruch
before the
Subcommittee on Science, Research & Technology
of the
House ~~of~~ Committee on Science & Technology
March 6, 1985

Mr. Chairman, members of the Committee, thank you for the opportunity to testify on the 1986 budget for the National Bureau of Standards (NBS) and on the Administration's plans for the Office of Productivity, Technology and Innovation (OPTI) in fiscal 1986. As the committee correctly perceives it, those two questions are "of a piece" and deserve examination together.

Before I start, however, please let me identify myself. I am Jordan Baruch, currently a consultant to industry in the management of technological innovation. From 1977 to 1981, I was Assistant Secretary for OPTI in the Department of Commerce. Before that, I was variously a Faculty Member at MIT, the Harvard Business School and at Darmouth College in both Engineering and Management. I have been in industry at Bolt Beranek and Newman and the General Electric Co. and currently serve on several corporate Boards.

My major concern throughout my career has been the task of converting knowledge into useful goods and services for society. That concern has caused me to be deeply involved — at the levels of government, industry and academe with the tasks of creating, developing and bringing to fruition the fruits of technology. Indeed, it is that concern that brings me here today.

The United States is currently suffering from a false prosperity. Even with our huge deficits, things seem -- at least for major segments of our society -- to be going very well. Despite this appearance, however, there is an underlying unease triggered by everyone's understanding that we can't go on borrowing from the future forever. A glance at our trade balance tells the story. Our negative balance of trade is larger than it has ever been, yet inflation hasn't yet struck. The fact is that although we're buying more foreign goods, money keeps coming in. Unfortunately, money goes out in the form of purchases -- foreigners become the new owners of that money. Money comes in, however, in the form of investment so foreigners still own those funds. In fact, foreigners own both the funds that are going out and those that are coming in. If and when they decide to repartriate the funds they have been investing here, the funds they have loaned to industry and the government, we will face a void that we will have to fill — and fill it we will -- even if that means printing the required dollars to do so or raising interest rates high enough to get them to change their minds about withdrawing their funds.

The roots of that sad -- if not terrifying -- scenario lie in two areas. The first, of course, is the fact that government is spending more than it takes in; the second is the fact that our goods compete poorly in the world markets. Unfortunately, these two root causes may demand solutions that seem to be contradictory. The coming budgets for the NBS and OPTI are prime examples of that problem. Managers who are resource driven, such as the OMB, the administration and the managers of some of our larger firms, attend only to stemming expenditures. Which expenditures to cut, and by how much are often dictated primarily by political or ideological constraints rather than by strategic needs. It is not unusual in those cases to find development or research costs among those most severely cut -- even when a rational strategy would dictate their expansion or, at least, their more detailed examination.

Managers who are opportunity driven, as are those we find in such organizations as 3M, Texas Instruments and others with exceptional track records, focus on the allocation of scarce resources to those activities that can best enhance the strategic needs of the organization. This style of management, of course, requires that the managers have a vision of the future, of today's needs and opportunities, and of the role that those opportunities can play in the organization's development. It is particularly difficult to find opportunity responsive management in an organization overwhelmingly peopled by resource driven managers; the competence is simply not there. When opportunity responsiveness is necessary, as it is now, an outside agent such as the Congress may be required in order to impose the rationality of opportunity management on an Administration's pattern of resource reduction without management.

Such is the role I intend to ask you to play today. I am going to ask that you selectively apply the rational pursuit of opportunity to your supervision of the budgets, tasks and structure of the NBS and OPTI.

Mr. Chairman, rather than review with you in detail the entire budget of the NBS, I have chosen three of its programs that typify three major productive roles that the NBS plays in order to convince you that the interests of the country are ill served by the current budget. Those three programs are the Building Fire program, the Center for Computer Science and Technology, and a group of programs that I have lumped under the heading of Automated Manufacturing.

- Building Fire.

The Administration has proposed reducing the budget for the study of Building Fires from $5.1-million to zero in 1986. An opportunity-driven manager would look at the Fire research program and ask several questions. Predominant among them would be:

  - Are the returns for what we spend likely to be significantly larger than the amount we spend?
  - Can we get the same benefits by getting someone else to do the job?

The first of these is easy to answer once we understand that the entire program costs less per year than one modest sized warehouse or office fire! It is a program dedicated to finding the best that science and technology can offer to prevent fires, improve the means for fighting them and minimizing their toll in property and life. It has been a striking contributor in each of these areas with benefits to society that far outweigh its costs. But perhaps that's where the rub lies. The program benefits society from Norwich, Vermont to Los Angeles, California but it doesn't have a direct set of benefits for the treasury. Indeed, I can fantasy Mr. Stockman pointing out to this committee that fires are a good thing! After all, the buildings get rebuilt so unemployment is reduced and we can collect more taxes. Of course, I don't really expect Mr. Stockman to testify that way this year, but the fact is that disasters like fire don't have a net negative impact on the Federal numbers and, since numbers are all Mr. Stockman seems to look at, we shouldn't be doing anything.

Mr. Chairman, this committee recognizes the fallacy in that train of thought. Society, the people, benefit greatly from the Fire Research Program -- as they do from our National Defense Program -- and they have hired the Federal Government to act on their behalf to invest in securing those benefits if no one else will do so.

That last brings us to our second question. Will someone else do the job? The answer is no; the reason, in Ted Levitt's immortal words lies in the fact that, "There is a market but no customer." Oh, it's conceivable that all the cities and towns or all the insurance companies could get together and form a Federated Fire Research Program but it wouldn't work. Any city that didn't want to pay could stay out and still benefit from the discoveries. They might then reinvent the Federal Government with its taxing authority to ensure fairness -- but why invent it if we've got it?

Let us conclude the fire section with a series of observations. There are programs in the NBS such as the Fire Program that operate in society's interest, that aren't assumable by others and that have large expected value. It is improper for the Government to reduce their investment in such programs as long as there are other programs of lower expected value per dollar spent. We will return to that concept.

o The Institute for Computer Science and Technology (ICST).

Programs like the Fire Research Program are hard to defend from number crunchers. We, as reasoning humans may be willing to stipulate that the cost of fire is so huge that spending a minute fraction of that cost with researchers of the quality that people the NBS is bound to be worthwhile. Number-crunchers or resource-driven managers aren't so inclined. Indeed, one of the most assinine responses I once heard in industry went as follows, "Twice as much as you're asking for would still be a tiny fraction, yet you're not asking for it, therefore, you're not very confident that you can produce value for the money. Given that, you don't get any." While I don't expect that kind of answer in Government, let me turn now to an area of Bureau activity that the guardians of the numeric can relate to.

In the Fire case, we looked at the Bureau functioning as an arm of the Federal Government to provide services to a faceless society. Despite the fact that that faceless society is the government's employer, its disaggregation denies it a voice in policy except through its representatives. But there are cases where the Federal Government actually does things and buys things. In some cases, those things are highly technical and the NBS serves as a source of technical wisdom in assisting the purchasers. In many areas, it also interacts with industry to ensure that the needs of the Federal government are well understood and well served.

While the Department of Defense is just coming around to recognizing the need for this kind of thinking in everything from toilet seats and coffee-pots to aircraft carriers and weapons systems, the Government as a whole has had such an effort in place in the field of computers for several years. The Congress, over the objections of many in the administration, charged the ICST with the responsibility for doing research, conducting studies and setting standards that would ensure the effective use of computers within the Federal Government. It was a good move. The civil portion of the Federal Government currently spends approximately $10-billion per year on computers, software and data acquisition. If we add in D.O.D.

and N.A.S.A., including only their non-incorporated, general purpose computers, that number is around $13-Billion. In each of the past few years we have spent 1/10 of one percent of that amount on the ICST to ensure the effective use and efficient selection of those expenditures.

If we look at just a selected group of the formal Federal Information Processing Standard that have already been issued, we find that the five year cost of developing them ran to $19.5-Million and their expected five-year payoff is $705 Million -- a rate of return of which even T. Boone Pickens could be envious.

The Institute, however, has been effective in a much wider area than just these information processing standards. ICST has been playing a major role in networking, computer information security, systems design and others. But, we might ask, can't the job be turned over to the private sector? After all, the tired refrain goes, don't they know much more about these subjects than plain old ineffective government folks? Well, if they do it's a crime -- or at least an invitation to one. Imagine letting the companies tell the government what's good for it. That's like letting General Dynamics specify aircraft performance for the Air Force.

In the ICST we thus see a second role of the Bureau -- establishing standards, rules and a body of knowledge in the direct interest of the Federal Government itself. It has done that job well, and the job is barely started. Over the coming years, the

Federal expenditure on Computers, Software and Data Acquisition will grow to some $20-Billion. I urge the Congress to reverse the folly that has led the Administration to cut the Institute's funding from $10-Million to $5-Million and to increase it sufficiently to permit ICST to do the job that needs doing. More than that, I urge you to examine the other programs of the Bureau for parallel programs that directly serve the Federal Government's needs and reduce its costs. There are many and they too should be reinforced.

- Automated Manufacturing.

So far we have looked at representatives of two classes of programs. The first serves real needs in society at a high payoff and does it as no one else will. The second serves real needs of the Federal Government at a high payoff and does it where no one else can be trusted to. Now we come to the third class of NBS program and one which is the pinnacle of their being. Earlier in this testimony I pointed out that our goods compete poorly in world markets. Lately, it has become fashionable to blame that failure on the strength of the dollar. Unfortunately, those people conveniently loose sight of how badly we were doing BEFORE the dollar experienced its spectacular rise. It wasn't the strength of the dollar that produced waves of Japanese cars and television sets. It was more value for the price. It wasn't the rise of the dollar that produced the stream of German coffee pots. It was more value for the price. Indeed, in the case of Sony TV sets and Krup coffee pots, their price is generally higher than American brands -- but so is their quality.

We could combat this foreign flood — indeed reverse it -- if we could make the diverse products that we can design at a price the rest of the world can pay. They have the money to invest here -- money we attract successfully, now let's get them to spend it here instead.

Fortunately, in a very few areas we have caught a glimmer of how to do this. When people look at the MACINTOSH computer from APPLE, they may not realize that its success, in large measure, rests on the phenomenal design of an almost automated factory that can turn out a MAC every 50 seconds! This kind of automated production holds a hint of how we can compete. The MacIntosh is successful overseas and is being exported in the face of an incoming tide of foreign goods. In fact, there are two kinds of automated manufacture that can help us to reverse this tide. One is typified by the MacIntosh plant; a single-purpose very effective plant with a moderate lifetime that will essentially be scrapped when the product life is over. A second type is the highly flexible plant that, while automated, can be reprogrammed to produce a diverse variety of products. Both have their place and both are being explored throughout the world.

A singular characteristic of such plants, however, is that the technology on which they rest is far from developed except in very specific cases. I won't go into the details of what needs developing except to point out that the technologies range from better near-net-shape forming of metals and composites to standardized systems for interconnecting robots and production tools. The needed technologies are of a sufficient diversity and scale that no one company or, in general, no one industry can make the investment in their development. And there we find the paradox. We know -- not surmise or guess -- we know the kind of development that can, in a few short years, make our manufacturers competitive with any in the world. It is a major, critically needed, opportunity. Yet our administration, driven by a non-strategic urge to cut expenditures, is suggesting that we forgo that opportunity. The Congress must impose reason, must help us recognize that magnificent opportunity and drive the country to its successfull realization. The NBS, in its collection of projects under this program has been limited to request less than nine-million dollars for the entire activity, an activity that could -- and should -- effectively use over $20-Million this year.

Mr. Chairman, members of the Committee, we have a problem. Our administration and the OMB have taken as their role model for management, the steel industry of the sixties, seventies and eighties rather than our successful enterprises such as 3M, IBM and Texas Instruments. In poker terms, they are playing their chips, not their cards. They are leading us into a loser's game and it rests with the Congress to pull us out. Our country isn't broke but it does have to recognize that there is a real difference between expenses and investments. We run thousands of programs that lie in the expense column; the NBS is one of the few -- the very few -- that lies in the investment column. The three examples I've given you represent highly profitable investment opportunities in services for the public, services for the Federal Government and services for industry. These are services that come about through the creation and application of knowledge. It is an area in which the Bureau excels; it is an area on which our future depends and it is one whose claim on our resources should at least equal the claim made by our investment in the national defense.

But the Congress might well ask why some outsider has to present this case; why isn't it made by the Secretary of Commerce or by the Assistant Secretary of Productivity, Technology and Innovation? In the case of the Secretary, of course, the answer is easy. He is charged with and attending to today's trade problems -- problems that range from the undesirable transfer of technology to the Eastern Bloc, to non-tariff barriers that exist in world trade. He is busy fighting fires and doesn't have the attention to give to the construction of our future.

In the case of the Assistant Secretary for OPTI, the answer is more complex but easily explained by looking at the budget. OPTI is currently run by an Assistant Secetary who is clearly brilliant and competent in integrating strategy, technology and investment. The Administration proposes to zero out the budget for that office -- to wipe it out. That's not an accident, nor is it attributable to the office's not doing its job. Quite the contrary, it is being wiped out because it does its job well! The slash and burn budget managers really don't want -- indeed can't tolerate -- a focus in the Adminstration that identifies investment needs and opportunities and has the skills to make the case for them. We saw the same phenomenon in the Steel Industry and we've reaped its results in the rust bowl. But why worry, that will happen to the country on some other Adminstration's watch.

I should point out that past Administrations, including the Administration under which I served, also had problems with investing in the future. Indeed, if we look at those cases where rational opportunity-driven investment has taken place, it has largely been the Congress -- over the various Adminstrations' objections that has forced reason on the system. Maybe it is right to wipe out OPTI. Maybe it is right because the fetters of OMB keep it from doing the job for which it was created. Maybe it is right, but we're going to have to reinvent it if it happens!

OPTI's strength (and that of its Science and Technology predecessors) has never been in the area of line management of the NBS, the Patent and Trademark Office, the National Technical Information Service or any of its other line agencies. Its strength has been in helping focus the limited resources allocated to those agencies on the problems impeding the country's economic development. It's strength has been in developing a technologically cognizant strategy. Indeed, any success it has had has been largely with Congress' help rather than through Administration initiatives. I see no sign that that condition will change -- a fact reenforced by the 1986 Budget.

It is a striking fact, however, that the need for the U.S. to have an effective office that can examine the Scientific and Technological activities of the Government and assess them as investments in our future is growing, not shrinking.

Mr. Chairman, members of the Committee, I will leave you with a difficult thought. You established the OTA primarily to examine and assess the negative aspects of technology, to prevent its proponents from destroying our future. I believe it is now time for you to establish -- as an instrument of the Congress -- an Office of Technological Strategy; an office that will work closely with the authorizing and appropriation committees to identify specific projects and programs where investment can buy us a brighter tomorrow. History tells us that only the Congress can do it, that only the Congress has the level of vision needed. The only question that remains is whether the Congress has the will in these difficult times.

I believe that it does and in that belief, Mr. Chairman, members of the Committee, I thank you again for your patience and the opportunity to testify here today.

JORDAN J. BARUCH
President
Jordan Baruch Associates, Inc.

Dr. Baruch formed the consulting firm of Jordan Baruch Associates, Inc. in January 1981 upon leaving his position as Assistant Secretary of Commerce in the Carter Administration.

As Assistant Secretary of Commerce, he served as the chief advisor on science, technology and productivity for the Secretary of Commerce and was responsible for the 7,000 employees and $250 million budget of the Patent and Trademark Office, National Bureau of Standards, National Technical Information Service, Office of Environmental Affairs, and the Office of Product Standards.

Dr. Baruch had previously served since 1974 at Dartmouth College in Hanover, New Hampshire as Professor of Business Adminsitration at the Amos Tuck School and also Professor of Engineering at the Thayer School of Engineering.

Prior to that, he was a lecturer in business administration at the Harvard University Graduate School of Business Adminsitration from 1970 until 1974. He was President of Educom, a consortium of 100 colleges and universities from 1968 to 1970. In industry he was general manager of the Medinet Department of General Electric from 1966 to 1968, and a founding partner - later Vice President of Bolt Beranek and Newman, Inc. from 1949 to 1966.

Dr. Baruch received his B.S. and S.M. in electrical engineering in 1948 and an Sc.D. in electrical instrumentation in 1950 from the Massachusetts Institute of Technology.

Dr. Baruch is a member of the National Academy of Engineering and of the American Academy of Arts and Science. He is a Fellow of the Acoustical Society of America; of the Institute of Electronic and Electrical Engineers; of the New York Academy of Science, and of the American Association for the Advancement of Science. He is a Registered Professional Engineer in Massachusetts, New Hampshire and Prince Edward Island.

Dr. Baruch is currently a consultant to industry on the management of technological change. In addition, he is a consultant to several foreign governments, assisting them in developing and implementing their industrialization plans.

Mr. **Walgren**. Thank you, Dr. Baruch.

I appreciate that business emphasis. We often hear that we operate government like a business. I do think in this area, at least on the floor of the House of Representatives, we haven't had the appreciation of government efforts in science as investments as opposed to spending or expenses. In a very real sense I think in our committee we realize that they are investments. I think we can reach agreement on lines to draw around Government activity.

We all believe in limited government, but we also believe in investment, and investment that pays off. I think on the committee we've been able to reach a substantial amount of agreement on that, but that has not translated outside of the committee because of the more superficial judgments that get made in our political process I'm afraid.

Dr. Millar, your testimony indicates that NBS covers, with respect to robotics, technical areas not replicated in any other place or in private industry, and for that reason alone they should be supported at substantial funding levels. Could you develop that a little bit more for our record?

Dr. **Millar**. I think the research facility at NBS has freedom to explore applications of robotics. In fact, the whole facility is essentially a complete robotic environment—we might not have the opportunity to do in industry. When we build a facility in industry, we normally do it to do a specific task, either it's a painting task or a task that's hazardous or uncomfortable or difficult that we choose not to use human workers on, and so as a result the investment made in industry to apply robotics is a very specific kind of thing.

We don't currently have laboratories in industry to do the kind of work that NBS does. The automatic manufacturing research facility at NBS is an imaginative installation, and it was built in a very special way, so that you could, in fact, explore the various applications of robots. You could begin to develop the interchange standards that we so desperately need in order to achieve the goal of the fully automated factory.

I think it's the right place to have that kind of a facility because the standards that come out, the interchange standards, the standards that we can apply so the computers and the languages of various hardware and software manufacturers can in fact work with each other.

We talk about cooperation between industry and government and the universities. We need that very same kind of cooperation between the various manufacturers of computers in the hardware and software which are generated, which we have to use to run our factories. And it's true the sorting out of that activity and doing it in an open way that's available to all manufacturers that choose to come and participate, in fact, then we build a very basic strength in the manufacturing community of our Nation which will be part of regaining the competitiveness which we must do to survive industrial as a nation.

So I think it's the right place for it, and I think it does something we can't do in industry simply because our focus is different.

Mr. **Walgren**. I see.

In the Bureau of Standards apparently some people are raising similar thoughts to what we had with the National Science Foundation. The thought was that the charter of the Science Foundation should be directed toward including engineering specifically in order to enable it to reach and emphasize engineering functions. And apparently the same could be said of the Bureau of Standards where programs of the National Engineering Laboratory may not be viewed as within their charter.

Do you feel that we should be incorporating in the charter of the Bureau of Standards, or the mission statement of the Bureau, specific recognition of engineering research and the like to support their involvement in those areas?

Dr. MILLAR. The report of the panel which I chaired makes that statement. That in fact we should do that; to incorporate in the mission statement of NBS a recognized broader scope of engineering activity in the world in which we live. I also personally believe that. And let me give you just a thumbnail sketch of the history on how I think we got there.

Science in many ways preceded engineering, at least in modern society. Engineering was sort of the hod carrier, if you will, for the thinkers over probably 200 years. And the National Academy of Sciences is—was created about the time of the Civil War. It was created under Lincoln's administration, 1865 or 1866; but the Academy of Engineering didn't come to light until just a little over 20 years ago.

So what's happened really in the fabric of our Nation is that engineering now has expanded in scope to encompass disciplines which formerly were just within the scientific framework, and as a result the dramatic expansion of the application of science, which is in fact engineering's role, is really in my judgment today one of the very key issues. And I think the Bureau of Standards, because it is part of the Government's interface, if you will, with the commerce of our Nation, has a proper role to play in embracing that activity.

What is engineering today, 200 years ago was science. And so as a result we will face some of the very same problems. And the Bureau occupies a very pivotal position in putting science into practical use through the mechanism of engineering. And that's why I, personally, feel and the committee recommended that the mission of the Bureau be looked at so that it in fact can be broadened to encompass what it already does so very well.

We suggest it, really, so that programs won't get knocked out every year simply because someone thinks they are not within the mission. What the Bureau does is OK as far as I'm concerned. The trouble is it's not interpreted as being within the charter. So I think, well, if that's the case, you know we have plenty of lawyers; the easy thing to do is change the charter.

Mr. WALGREN. I see.

Dr. MILLAR. And the right thing to do in my judgment.

Mr. WALGREN. Well, I think that we ought to think about that. I know my first reading of the charter was that it was quite limiting. In many ways I think we've allowed the Bureau to do some things just because they weren't particularly controversial, and they weren't stepping on too many toes, and they turned out to be very valuable things. Yet I don't know that we view the Bureau with the proper degree of appreciation for their product, because their charter doesn't reach that product.

Dr. MILLAR. Of course, the focus of the charter is on metrology, or the science of measurement and the developing and retaining of those standards as a derivative of that activity. But there isn't anything we do today in industry anywhere that doesn't demand some kind of standard, some kind of methodology. And we have to broaden the scope of what we really consider standards. That's why I mention again IGES, the graphics exchange standard, for example. That's not a block of anything that you can keep at a certain temperature. It's an intellectual standard.

And so as you begin to look at what the Bureau really does and the science and the methodology and the engineering it takes to support the development of those activities, then in fact you are, in my judgment, conceptionally within the charter but, unfortunately, not within the language of the charter.

Mr. WALGREN. I see.

Dr. MILLAR. And so I really believe that we should recognize that and recognize the Bureau for what it is and how it contributes to the health and well-being of our Nation, and draft language which will allow it to function without harassment by the budget cutters.

Mr. WALGREN. Um hum.

Mr. RITTER. Will the gentleman yield?

Mr. WALGREN. Be happy to yield.

Mr. RITTER. Thank the gentleman.

You know I would agree on that point, and I think that this, what we are seeing today is a reevaluation of the missions of many of our Federal Government's R&D facilities. And I think the point that you brought up in allowing some of these charters to change with the times is a very good one, and I would just submit that this is not just relevant to the Bureau of Standards, which we are certainly herewith today in detail, but it's probably relevant to a number of other Government R&D facilities which had one mission at one time, they are still operating under the same charter given that original mission, and yet times have changed dramatically in terms of the needs imposed upon the system and the ability of these marvelous facilities to respond to those needs.

Dr. MILLAR. And we—and there's a good example right in this room because as you know NASA didn't start out as NASA, and yet it's basically the same organization. It was originally NACA which dealt with airplanes that just barely got off the ground, and designed the cowlings and things of that nature. But as time went on and as we began to reach farther and farther, and go faster and go higher and finally into areas where you had to convert from wing flight to some ballistic form of transportation, the agency changed. And so it's not impossible to do.

Mr. WALGREN. Dr. Baruch.

Dr. BARUCH. I'd like to second your thoughts and Mr. Ritter's thoughts. Changing the charter of the Bureau is like changing the charter of the National Science Foundation, a necessary first step in changing its culture. One of the problems we've had at the National Science Foundation, as at any science-based organization, is recognizing the contribution and the role of engineering. Engineers continually make decisions based on incomplete data. That's anathema to scientists, but we do it all the time. We have no choice. It's one of the reasons that engineering often drives science.

But it's necessary.

Mr. RITTER. I figured Paul was saying some pretty good things before.

[Laughter.]

Dr. BARUCH. I hope you can change the record accordingly.

I think changing the charter is essential if we're going to get engineering and science on the kind of complementary supplementary footing that it really needs in the Bureau as it does within NSF.

Mr. WALGREN. If the gentleman would yield back?

Mr. RITTER. Yes, I will yield back.

Mr. WALGREN. Along that same line, I confess the need to be taught what's going on here. Regarding a national engineering laboratory and a national engineering data base, we presently have the laboratory?

Dr. MILLAR. The National Engineering Laboratory exists.

Mr. WALGREN. And it exists where?

Dr. MILLAR. Within the National Bureau of Standards.

Mr. WALGREN. And is that the proper place for it?

Dr. MILLAR. I think it is. Yes.

Mr. WALGREN. Are there limitations that they are feeling in developing what is known as a comprehensive engineering data base?

Dr. MILLAR. The engineering data base is really a relatively new idea. And I'm not totally sure I can tell you precisely how it should be done because it hasn't been studied to the degree, in my judgment, that would allow me to do so. But we desperately need it in industry, and as Dr. Baruch said, engineers operate with incomplete data, we would like not to. And with some of the very powerful communication techniques we have available today an engineer could sit at his work station, for example, if he had access to some of the physical properties of material, electrical properties, whatever he might need, and poll or query, if you will, a data base that would have this information available to him. We now work with handbooks, which are very, very limited in their scope. Some of the information is available from the paid wire services, the paid computer-based sources, but it would seem logical that the Bureau might be a repository for the collection, the organization and the dissemination of that information on a real-time basis to practicing engineers in the field.

How far that thinking has gone, I can't—I simply don't know. But at the meeting of our panel last spring, the idea was surfaced, we took a look at some of the possibilities, and the report simply reports to you and others the feeling of the panel that it was worthwhile to look at.

Mr. WALGREN. I see. On the same point, Dr. Baruch?

Dr. BARUCH. Yes. May I just make the remark that not only does the laboratory exist, it is held in a high regard in the engineering community, and I would just like to mention that its Director, Dr. John Lyons, was recently elected a member of the National Academy of Engineering. He's sitting right behind me.

Mr. **Walgren**. I know Dr. Lyons and see him there. I apologize for not knowing the name of entity for which are you responsible, and where it is at this point.

Mr. Ritter?

Mr. **Ritter**. I thank the chairman. I've got just a couple of questions.

Dr. Millar, you were very much one of the key figures in the automating of the John Deere fully automated robotized tractor manufacturing facility. So, in your opinion, are we competitive in the technology evolution of robots? And I use the word "technology evolution" as opposed to research or development.

Are we turning out the kind of technology in a competitive way in this field of robotics?

Dr. **Millar**. First, let me clarify one point. I was involved in it. I have to say that there were others probably more responsible for its eventual creation. It was a team effort. And my concern was how we designed product to be manufactured by the automatic facility rather than the automatic facility itself. But it meshes together.

And we did that project almost 10 years ago. And you have to realize at that time very little was known. We did not have the Automatic Manufacturing Research Facility of the National Bureau of Standards or anyplace else to go to get information. So we did it pretty much by ourselves with some help from the manufacturers of the machine tools and certain consulting firms. But as robotics has grown and as the field has moved very rapidly you will find most of the robots themselves, the units, are manufactured offshore. And that leads me to believe, at least, that the industries of Western Europe, the industries of Japan, and some—and now we're beginning to look at Korea—have developed a capability that challenges, if you will, our understanding of the robotic environment.

To make a quantitative statement that says they're better than we are, we're better than they are, is extremely difficult because I'm sure in certain areas, maybe in spot welding, we probably know more about that than our offshore competitors. But in pick-and-place activities maybe it's not that way.

The real limitation of robots today, and this is true both domestically and in the offshore communities, is the fact that they're primarily memory machines. That, for example, to give you—tell you how we do something with them, we paint a machine by having a painter, a good painter hold the arm of the robot and paint whatever it is. And then the robot faithfully reproduces those motions and the flow of paint, and as long as the device that was being painted is identical, each time and position precisely the same, then the robot does a good job. But if it's a little different device, a little different product, or if it's not precisely in the same location, the robot really doesn't know that.

And so the next step in robotics is got to be some kind of a vision process. And then as we go from vision, we may have to go to touch, and then, of course, eventually voice recognition. In those three areas I am personally not satisfied that we are as competitive within our North American industries as we should be. I can't go beyond that because it's a newly emerging kind of engineering activity, but the next quantum jump will be, in effect, to develop three-dimension vision systems, some kind of touch process, and I think eventually voice recognition.

Mr. RITTER. Since so many of the R&D advances were American, why are these being manufactured offshore in bulk—in the main?

Dr. MILLAR. All I know is that as you go through the—well, let me tell you one reason. And that is the manufacturer of the robots, there is two basic categories of activity. One is the application of robots, and that takes—that applies very specifically to the facility in which you put them. And I think we've done a fairly respectable job in applying robots.

The manufacture of the robots is a little different class of activity, and one of the reasons is that the robots are lower cost and we get shorter delivery times. And there are some very good robots made in the United States, but a lot of them are made offshore.

And my gut reaction is that some of the offshore robotics manufacturers are, let me put it this way, extremely competitive with North American manufacturers.

Mr. RITTER. Dr. Baruch?

Dr. BARUCH. Mr. Ritter, one of the reasons we find a lot of this going on offshore is that when robots were first introduced—Unimation was one of the originators—they were adapted and applied in Japan at about 20 times the rate that they were applied in American industry. We didn't believe in them. We didn't bother with them. The Japanese did. Since there was an intense Japanese market for them, there became an intense Japanese supply.

Mr. RITTER. So the only supplier that's really of volume out there is that Japan?

Mr. BARUCH. No. Since then it's spread to Germany, and it's coming back to the United States because we are putting more of them into use.

Dr. MILLAR. Unimation is very competitive.

Dr. BARUCH. Yes. It is worthwhile, though, if you ever have a chance to go to Japan, that you go to a town called Tskuba, the science city in Japan, and see the Fujitsu-Fanuc installation there where you'll find a very active bunch of robots manufacturing robots.

Mr. RITTER. Yes, I was in Tskuba recently and, how should I say it? It's scary. But it also shows us what can be done with the right kind of resource application and teamwork.

Dr. MILLAR. One of the reasons I think that happens is that we tend to be extremely close coupled in industry, and that's why—one of the reasons the Automatic Manufacturing Research Facility of NBS is so critically important. It can do some of the things earlier in the cycle than we might choose to do them in industry. And I suspect that our offshore competitors tend to start things a littler earlier in the cycle than we do. And I believe we're going to work our way out of that problem, simply because if we don't we're not going to be competitive, and now that the wolf is in the door, why we are going to try and solve the problem.

Mr. WALGREN. If the gentleman would yield, we clearly have time for another round of questions, and I wanted to recognize Mr. Cobey at some point.

Mr. COBEY. I have nothing.

Mr. WALGREN. Fine. Then, Don, please continue.

Mr. RITTER. I have one quick question.

Dr. Baruch, I agree with many of the things you outlined in your testimony, and I guess, frankly, I guess I don't take some of these budget cuts quite as seriously as you do, because I think some of these things are going to go back in. But nevertheless that remains to be seen.

You mentioned, though, that it's necessary for an outside agent such as the Congress to impose the rationality of opportunity management on an administration's pattern as resource reduction without management. But you know, other than replacing some of the things that should be replaced, I'm not sure Congress is the greatest place to look for opportunity management, and in many ways some of the great weaknesses that loom on the horizon of the economy as opposed to the great strengths that have evolved in the economy, seems to come from some of the actions of Congress. Certainly the Federal deficit is more a function of Congress than any administration. Certainly the regulatory morass and the lack of scientific basis to that morass is more a function of regulating through legislation and political responses to sometimes technical problems.

Do you want to clarify that?

Dr. BARUCH. Yes. I think you've just demonstrated by your two examples, the deficit and the regulatory morass, that Congress has the power and the strength to do major things and do them badly. What I'm suggesting is a slight change where it will continue to do major things and do them well. I think in any company——

Mr. RITTER. I hope that's not expecting too much, but go on.

Dr. BARUCH. I think I have a right as a taxpayer to expect at least that. And I'm going to insist on it.

Let me point out in a company like IBM, the senior executives of IBM really don't have the detailed knowledge of the technology of holographs or phase diagrams, or Josephson junctions on which to make decisions. Nor do they, as was suggested earlier, feel like turning over the resources to the scientists and just trusting them to do good things with them. They want to evaluate, and they have many tools to do this with. They get groups of scientists who have managerial viewpoints. They hold shootouts among conflicting ideas. They use a wide range of tools and they make decisions.

The authorization committees of the Congress and the appropriation committees of the Congress make decisions all the time. Now, you can argue that since they have made decisions poorly in the past we shouldn't let them make any more decisions. I don't think that's right. I think you can get the tools together in the Congress to make those decisions well, in a way that the executive department really can't. And I am sort of challenging you to try it.

Mr. RITTER. I accept the challenge, and of course that's what people like Doug Walgren and myself hope we are doing here. But I also would—I also would propose that the fundamental discipline of a bottom line, that finally at some point at IBM, somebody has made a decision on whether or not this thing either short or long range will make money. Our bottom line has nothing to do with that kind of analysis. It's very different, that political bottom line.

Mr. BARUCH. I've lived with it for 4 years, as you're aware. But now we're talking about some marginal activities that are small compared to many of the expenditures that you're going to make. And I'm saying that there is an area where it might be very, very salutary for Congress to experiment with rationality. I don't mean that pejoratively. I meant rationality in the economic sense as opposed to the political sense, which is what most decisions are rightfully made on.

But I think it's a task worth trying. And if you don't do it, I don't see anybody who's going to. And that's saying that we have no way of investing today's taxes in the country's future.

Mr. RITTER. Well, I agree with you there. I—there are elements of what I call seed corn that need to be planted and that are not about to be planted by—by a corporation looking at each quarter and looking at the price of the stock. And NBS certainly has, I think, proved its mettle in these areas. So I guess that's what these hearings are all about.

Thank you.

Mr. WALGREN. Thank you, Mr. Ritter.

Mr. Fitzgerald, thinking of the Center for Fire Research and some of the long range goals that they have, have you seen any progress in this last year on the computer modelling of fire development? That was raised last year as something of real potential. What's been our experience this last year, and how do you sense it developing?

Mr. FITZGERALD. Computer modeling is definitely a long range research program. Has there been progress in the last year? Definitely so.

Speaking very specifically, for example, on a program that we have that we're working in concert with the CFR staff, we have developed a computer model that would predict the interaction of a sprinkler droplet with fire sizes of different types. That has progressed very well, to the point that it's even moved into our applied research program.

The other aspects of computer modeling largely depend on nailing down some of the chemical and physical phenomena associated with fire growth and ultimately fire extinction, and that will take some time.

But very clearly the Center has developed models that recreate certain scenarios, the information is valid. It's a question now of making it grow and expand into other areas, and ultimately I think it's going to be the most single important tool that practitioners—again, the code authorities, the engineers, and the like—will have for making cost-benefit decisions regarding improved fire protection.

But there has been definite progress, yes, sir.

Mr. WALGREN. Do you see their work translated out into building codes and things like that at present?

Mr. FITZGERALD. At present, no. Absolutely that will be the end result. Computer models will, in my view, and as we're seeing it, will be one of the major vehicles, one of the two major vehicles for transferring research results to the code officials, local authorities, and the like, because of their ability—and also designers and engineers—because of their ability to permit scenarios to be developed on a computer in a very cost effective way and by so doing recreate worst credible cases, worst credible design cases.

Mr. WALGREN. I see.

Mr. FITZGERALD. I might add the comments by Dr. Millar dealing with the data base, that will be the second way that this information will be transferred out. And very clearly the building of a fire research data base along with the interactive systems of the type he described, expert systems and the like, very clearly is also something that will be very important and the two of them I think will be married some years down the road. That I believe will be one of the great advancements in implementing, that's beyond the research phase, but in implementing improved fire protection practices in this country some years in the future.

Mr. WALGREN.

Well, let me thank you all on behalf of the subcommittee. We sure appreciate what you've done to make your presentations, and I appreciate the contribution you've made to the record. It's very helpful.

With that, we'll be adjourned.

[Whereupon, at 4:20 p.m., the subcommittee was adjourned, to reconvene subject to the call of the Chair.]

APPENDIX I

IBM International Business Machines Corporation

Office of Vice President
and Chief Scientist

Armonk, New York 10504

March 22, 1985

The Honorable Douglas Walgren, Chairman
Subcommittee on Science, Research and Development
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Doug:

I am glad to respond to your request for comment on the FY 1986 NBS budget based on my experience as a former Director of the NBS, and in both governmental and industrial research and development for the last 34 years. I am not expressing a formal position of the IBM Corporation.

I do share with the Corporation, however, a very serious concern about the necessity of bringing the federal budget under control. Neither military nor civil programs can be exempt from the most serious scrutiny for their necessity and efficiency. Most of the change in the NBS budget, however, is in the form of a major reprogramming. The Bureau being a relatively small and quite unique organization, should be examined in the context of the nonmilitary federal science program as a whole.

I am very pleased to see the expanded emphasis given by NBS to scientific research in materials, science and engineering. Work on the characterization and properties of polymeric and ceramic materials will be of great importance to industry. Although the budget submission focuses on application to bulk materials of structural interest to the aerospace industry particularly, the microelectronics and computer industries are equally dependent on progress in polymer and ceramic science. I would hope the actual program is balanced between structural and electronic application areas.

Indeed, great importance is attached to the U.S. maintaining its lead in materials science and engineering. The IBM Corporation announced last December a $25 million program of grants to U.S. universities embarking on new programs of interdisciplinary, fundamental research in this field. The Bureau has a unique and essential role to play in the national effort to provide the scientific basis for studying materials and managing their engineering applications. The organizational elevation of the Materials Research Center and the new element in the program structure are recognition of the importance of this role.

My regret is that the Administration proposes to fund these new programs by dramatic curtailments in three areas in which the Bureau has made distinguished contributions to the public welfare, on top of across-the-board budget cuts. In addition, there are a series of other reductions in the base adjustments and in the program, all in the laudable cause of budget reduction. I suggest that the Committee ask the Bureau's management to detail specifically the effect of these base reductions on NBS program and research capability.

The three areas slated for elimination or drastic reduction are in Computer Science and Technology, Building Technology, and Fire Research.

The budget proposes cutting the appropriation for the ICST from $10 to $5 million. It is important that the government possess a center of technical competence in computer and telecommunications systems technology available to the civil side of government and knowledgeable about the rapidly evolving technology in the private sector. The Bureau is frequently asked, why does it need to do research in an area where U.S. companies invest billions annually in R & D? It is precisely for that reason that the NBS must provide expert technical support for government agencies whose decisions may have critical impact on the most rapidly growing sector of our economy. The industry is moving so fast that the NBS cannot expect to sustain the needed level of competence on a shoestring budget.

Let me give you three examples of reasons for sustaining the research competence of NBS in computer science.

The Export Administration Act commits the Commerce Department to developing regulations to control exports of both technical information and products in the computer field where these "dual use" technologies could be of military importance. If this task is carried out well, it can make a contribution to military security. If done badly, it could set back the U.S. lead in the computer industry that the law seeks to protect. The Department should have at NBS, its own in-house technical expertise to help resolve the many technical questions that will arise in the effort to strike the right balance between trade and security.

The area of computer and communications security, including the use of cryptography as a commercial data protection mechanism, is also of vital interest both to government and to commercial enterprises. While the NSA has great expertise, unmatched anywhere else, it is still important that the Commerce Department retain an independent capability to evaluate commercial requirements and bridge the differences between the government's and the private sector's views on this subject. Data security is a wide ranging technical topic; competence cannot be maintained without some depth and breadth of staff experience.

A third area is also of great importance to industry: international standards for interconnection of computer networks. The NBS budget submission states that this activity will be retained and given priority. It is important that it should be, for the opportunity for both computer and telecommunications companies to be successful on world markets is affected by the government's ability to understand the issues and provide for appropriate representation of U.S. interests in the ongoing intergovernmental negotiations in the CCITT, the EEC, and other bodies.

This too, is a highly complex field; it cannot be mastered by a handful of people, no matter how conscientious they may be. I am glad the NBS intends to continue its work in this area, but I am not sanguine that a technical group cut in half by the budget reduction can, in fact, stay abreast of this very complex and rapidly moving field of technology. Staying abreast requires active contributions to research in the field. If NBS is unable to do this, their credibility as a technically well-informed, but disinterested party will be threatened and their usefulness greatly reduced.

Regarding Building Technology and Fire Research, the NBS budget says these matters are the proper concern of states and localities. That is, of course, true and the Bureau's policy has been based on that very proposition. The Bureau helped to create the National Conference of States on Building Codes and Standards, and provides essential technical support to permit the states to harmonize their codes and base them on performance standards. When I was Director of NBS, there were 13,500 separate building code jurisdictions. The Bureau helps a highly fragmented building industry to aggregate a national market and introduce productive new technology.

The Bureau's role here is a model of federal participation as a very modest, but essential partner with the states in a matter of great public importance. The Building Technology Center has served with great distinction for decades. Retrenchment may be necessary, but I cannot imagine that the Congress will want to see this fine institution terminated. I am quite certain that nothing comparable will arise to replace it, either private or state-based.

The Fire Research Center also works with the states in a supportive role, pursuant to specific legislation. Here, a matter of public safety is centrally involved. The U.S.A., a leader in many other areas, has for many years had one of the highest fire loss records in the world. Our fire services had little in the way of technical support until they sought the Bureau's expert help. How many lives have been saved by these efforts in the past 10 years, I do not know, but the Committee should think seriously about the true costs attendant to proposed budgetary savings.

Perhaps it is anticipated that the other agencies who reimburse NBS for services in the computer, fire, and construction areas will continue to do so, and by this device the nation will retain at least some of the benefits of the NBS expertise. If so, this hope may be an illusion. Long experience with other agency-funded programs shows that only in areas where NBS has ongoing research funded on the direct appropriation can an adequate level of competence to support other agencies be maintained. The ratio of reimbursed funds to the appropriation should, in general, be limited to about 35 percent.

In summary, let me note that the areas of technical research slated for curtailment--computers, construction, and fire--are very difficult areas of work, requiring not only technical expertise that is in short supply, but years of experience in cooperation with both private industry and state authorities. Once shut down and the staff dispersed, they cannot readily be recreated.

In setting priorities, I urge the Congress to keep the heart of these programs healthy, even if some retrenchment is necessary to permit the new. It is very important to make a substantial start on the materials program, as the Administration proposes. Doing both will certainly require a reexamination of the reasonableness of the total budget request. In judging that, I suggest the Committee look at the percentage rise in the much larger NSF budget as a guide to affordability in a very difficult budget year, recognizing the functional complementarity of these two agencies. Even if the NBS budget must be held flat, in a year when closing the budget gap must have the Congress's primary attention, I believe the measures taken to restructure the Bureau's program are too extreme.

Sincerely,

Lewis M. Branscomb

LMB/sbb

cc: Dr. E. Ambler, Director
U.S. Department of Commerce
National Bureau of Standards
Washington, D.C. 20234

SUMMARY COMMENTS OF
DR. PETER CANNON
VICE PRESIDENT-RESEARCH
AND CHIEF SCIENTIST
ROCKWELL INTERNATIONAL CORPORATION
TO
COMMITTEE ON SCIENCE AND TECHNOLOGOY

My testimony is concerned with the Center for Materials Science, as I am most familiar with it.

The reorganization of the Center for Materials Sciences has resulted in a series of world-class materials science initiatives. The various divisions remain focused on metallurgy; polymers; inorganic materials; fracture and deformation; and reactor radiation; as well as the Office of NonDestructive Evaluation.

The revamped Center is concerned also with information gathering and retrieval and distribution, particularly in the areas of phase diagram research and corrosion data. These new activities are consistent with the Bureau's original purpose. Differences from historical standards and reference management patterns have to do with the necessary use of computer networking and the sheer volume of information handled today.

The Center's research in generating standards and reference data can be categorized into the four areas of materials processing; materials characterization vis a vis microstructure; properties vis a vis intended use; and performance. Work in nondestructive evaluation augment the latter three areas, where the introduction of time is important, as regards durability and extent of "life-remaining."

In recent years, the Center has been at the forefront in its participation in national materials policy deliberations. It has sought exposure through hearings testimony, membership on various commissions looking into specialized materials topics, participation in conferences and workshops, and working closely with those in the Office of Science and Technology Policy (OSTP).

Of particular interest are two important adjuncts to Center goals. One, Congressman Don Ritter (R-PA) for a year has had assigned to his staff the manager of the Office of Nondestructive Evaluation. Two, the former acting director of the Center for Materials Science is now executive secretary of the Interagency Council on Materials. Undoubtedly these two appointments will greatly invigorate national materials policy.

SUMMARY COMMENTS OF DR. PETER CANNON

The productivity and profitability of American manufacturing efforts depend heavily on innovations in materials science and engineering. "Innovation" includes inventing new materials by substituting new for old systems and infusing new product life and improving margins; and by devising more efficient and more reliable process methods.

Traditionally the Bureau sought excellence in reference data on classes of materials; this responsibility extends now to the time-based dimension of evaluation and prediction of structural life. This added dimension influences buying decisions of product users world-wide and is a strength of the American aerospace and computer industries.

Improved productivity and competitiveness require increases in staff and budgets, both of which have remained low in some areas. A real concern is the volatility of "other agency" funding, which means short-term programs must be balanced against longer term strategic goals. Resolution of such a practical difficulty may effect termination of long-standing programs which are no longer so relevant to the new emphasis on productivity.

Center success is greatly dependent on dedicated, able staff. Incumbent on the director and his chiefs is retention of current staff and effective competition for new graduates. Potential budgetary freezes and cutbacks are real causes for concern. Major capital investment appears worrisome, although less uncertain.

Center budgetary issues are shared by first-class industrial laboratories. In essence, sufficient budget is available to complete tasks; but the parent organization provides inadequate money.

The inherent danger in such a policy is that strategic organizational goals run the risk of being compromised. While I do not discount certain benefits derived from soliciting external funds, goodwill and external funding should not become essential to operating core programs.

Of great concern is the real possibility of the loss of key people and of program instability.

The high budgetary priority of the Cold Neutron Research Facility will greatly enhance the nation's capability to meet foreign competition in this rapidly growing field of research. Critical scientific and technological problems and opportunities in materials science, condensed matter physics, chemistry and biology can be addressed only with cold neutrons. This major new facility will greatly benefit not only the programs of the Center for Materials Science but the scientific and mission activities of many other Bureau Centers.

STATEMENT OF THE
AMERICAN SOCIETY OF CIVIL ENGINEERS
REGARDING THE
FISCAL YEAR 1986 BUDGET
FOR THE
NATIONAL BUREAU OF STANDARDS

SUBMITTED TO THE
SCIENCE, RESEARCH AND TECHNOLOGY SUBCOMMITTEE
SCIENCE AND TECHNOLOGY COMMITTEE
UNITED STATES HOUSE OF REPRESENTATIVES

AMERICAN
SOCIETY OF
CIVIL
ENGINEERS
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Washington, D.C.
March 6, 1985

The Administration's fiscal year 1986 National Bureau of Standards (NBS) budget proposal once again calls for the elimination of the Center for Building Technology (CBT) and the Center for Fire Research (CFR). The rationale is that these programs are more properly the role of the private sector and state and local governments. Frankly, the Society is surprised and disturbed that the Administration is once again trying to zero out these programs. Numerous statements were filed on behalf of a variety of organizations that stressed the valuable role performed by the Center for Building Technology and the Center for Fire Research after the fiscal year 1984 and 1985 budgets attempted to eliminate these programs.

As we did in the last two years, ASCE wants Congress to know that it strongly supports the Center for Building Technology and the Center for Fire Research and opposes the plan to eliminate their budgets in fiscal 1986. The specialized laboratory facilities and the professional staffs of the Center for Building Technology and Center for Fire Research are public resources that should be more fully tapped, not diminished by budgetary concerns.

CENTER FOR BUILDING TECHNOLOGY

The Center for Building Technology is the national building research laboratory. It performs field, laboratory and analytical research to develop measurement techniques and to evaluate the properties of construction materials, components and systems. The program includes substantial efforts in advanced computation and automation, structural engineering, earthquake hazard reduction, building physics, materials and equipment. Civil engineers need sound technical information to make responsible and cost-effective decisions in the building process.

On a larger scale, CBT is the only research program that integrates complex technical issues affecting the vast building industry. Despite the fact that it amounts to about 10% of the GNP, and that almost two-thirds of the nation's wealth is invested in constructed facilities, the building industry is very fragmented. CBT provides a uniform base of information, and serves as a unifying force for the entire industry. Because of the industry's size and diversity, no part of the private sector can duplicate these efforts or adequately distribute the findings on its own. This interdisciplinary laboratory also integrates complex technical issues in a way that more narrowly-focused proprietary research and development cannot.

Some of the unique and valuable aspects of the CBT are:

- Unique and comprehensive facilities such as a tri-directional structural test laboratory, 12-million-pound testing machine, environmental chambers, guarded-hot-plate and calibrate hot-box, plumbing tower, anechoic and reverberation chambers;
- An integrated, nonproprietary program for removing technological market barriers of the construction industry as well as reducing unnecessary or ineffective

building regulations without compromising essential levels of safety. This is the major technical information source for the development of voluntary standards by groups such as ASCE;

- A quality assurance program for hundreds of laboratories used by designers, owners, builders and state and local governments responsible for building and transportation.

CBT also provides the authoritative laboratory support for federal agencies that need assistance in developing criteria for the design, construction and maintenance of their facilities. Although we cannot offer a financial analysis, it is likely that the technical support from the CBT provides the federal government with savings in the life-cycle costs of its buildings that annually exceed the budget authorizations for the Center. The elimination of funding for the CBT would result in the loss of a productive investment.

The following case ilustrates the vital role CBT provides to the building industry. On January 1, 1985, the management responsibility for the ANSI A58-1982 Standard, "Minimum Design Loads for Buildings and Other Structures," was transferred from CBT to ASCE. This standard is the only nationally recognized voluntary concensus on structural loads in the United States. It is widely used as a resource document by other codes and standards groups, regulatory authorities and engineers confronted with unusual design situations not covered by building codes.

Though management of the Standard will now reside with ASCE, and thereby with the private sector, CBT will continue to be the principal source of new technology to update ANSI A58. CBT programs such as Wind Loads on Buildings, Seismic Design Criteria, Floor Loads, Fire Loads, Reliability Analysis and Design Analysis have been and will continue to provide invaluable input for the standard. Without future technological support by CBT programs, the future of this important standard will be seriously compromised.

CENTER FOR FIRE RESEARCH

The Center for Fire Research also contributes to public safety in a way that no privately-funded research effort could. CFR explores the processes that initiate, propagate and suppress real fires. As a result, realistic material test methods, cost-effective fire safety design concepts, and new methods of fire control and extinguishment can be developed. Like CBT, CFR does not promulgate or enforce standards or regulations. Instead, it provides technical support to voluntary standards and model codes groups, engineers, the building industry and fire organizations.

Some of the effects of the proposed elimination of the Center for Fire Research include:

- Over 100 standard-writing and code committees will lose their source of technical information. None have their own laboratories or technical staffs;

- The flow of information to the building industry on fire safety technology will be reduced. CFR operates major programs in sprinklers, smoke control, smoke detection and building design;
- CFR's fundamental fire research program is directed at reducing fire protection costs through improved codes and standards and less redundancy in fire protection. The cost of providing fire suppression forces and built-in fire protection for buildings currently exceeds $20 billion annually.

The termination of this important research would essentially stop the development of fire control technology in the United States. If the specter of eliminating life-saving opportunities does not deter efforts to zero-fund the CFR, the cost-saving opportunities should persuade a budget-conscious government to reconsider the proposal. Fire-safe building design techniques can save money for all sectors of our society. Without the CFR, fundamental research programs will stop and engineering criteria will no longer be generated. Such an approach is deleterious to the economic interests of the American people and threatens all our lives.

While the Society applauds and shares the commitment to reduce the federal budget deficit, it also warns against needless elimination of programs that not only are essential but also cannot be duplicated in the private sector. The services provided by the Centers for Building Technology and for Fire Research are invaluable to an important sector of our economy, the building industry. As in the past two years, ASCE is urging Congress to save these vital programs from extinction.

AMERICAN SOCIETY OF CIVIL ENGINEERS

The American Society of Civil Engineers (ASCE), founded in 1852, is the oldest national engineering society in the United States. Membership, held by 100,000 individual professional engineers, is about equally divided among engineers in private practice; engineers working for federal, state or local governments; and those employed in research, industry, construction and academia. The Society's major goals are to develop engineers who will improve technology and apply it to further the objectives of society as a whole, to promote the dedication and technical capability of its members and to advance the professional and economic stature of civil engineers.

CBEMA

STATEMENT OF
THE COMPUTER AND BUSINESS EQUIPMENT MANUFACTURERS ASSOCIATION
TO
THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
HEARING ON FY 1986 AUTHORIZATION OF NATIONAL BUREAU OF STANDARDS

The Computer and Business Equipment Manufacturers Association (CBEMA) is submitting this statement in response to the proposed reduction in funding for the Institute for Computer Sciences and Technology (ICST) of the National Bureau of Standards (NBS). CBEMA is the trade association of manufacturers and assemblers of information processing, business and communications products, supplies and services. Its 38 member companies had combined sales of more than $111.5 billion in 1983. They employ more than 1.2 million people worldwide.

CBEMA is deeply concerned about the proposed 50% reduction in ICST funding. We regard ICST as a critical national resource for focusing the Government agencies' requirements and representing these requirements in arenas where national and international standards are developed. As a part of the National Bureau of Standards, ICST is uniquely situated to be an effective, impartial negotiator in the standards development process. It promotes voluntary international standards that preserve U.S. industry's competitive positions in the world market, while supporting users' needs for standards to achieve increased productivity and delivery of services at reduced cost.

The current program addresses:

- Computer networking
- Hardware interfacing
- Office automation
- Languages and software development
- Database technology
- Flexible media such as discs
- Computer graphics
- Document interchange
- Security procedures and technology

The ICST has provided informed leadership and guidance to the federal government in these areas as well as informing and assisting the private sector. Work in each of these important areas would be severely reduced or eliminated under the proposed reduction.

Computer and Business Equipment Manufacturers Association 311 First Street, N.W., Suite 500, Washington, D.C. 20001 (202) 737-8888

This is the fourth consecutive year that a drastic funding cut has been proposed for the ICST. In the past, Congress has restored the proposed reductions, recognizing that no other private sector or governmental organization can adequately provide these critically needed services.

ICST's cooperation with the computer industry and its users is very important to America's productivity and its competitiveness with the rest of the world. Last year our industry contributed a positive balance of trade in the amount of $4.755 billion to the United States economy. America needs a strong standards program in the computer networking and telecommunications technologies to maintain our competitiveness in these areas. ICST has a key role to fulfill in supporting development of the needed standards.

CBEMA strongly urges that the ICST budget for FY 1986 be funded at the same level as FY 1985 to continue this essential program.

Remarks by

Albert M. Navas

President

American National Metric Council

to the

U.S. House of Representatives

Subcommittee on Science, Research, and Technology

Hearings on the

Office of Productivity, Technology, and Innovation,

Department of Commerce.

March 6, 1985

I AM ALBERT M. NAVAS, PRESIDENT, AMERICAN NATIONAL METRIC COUNCIL, AND AM PLEASED TO OFFER THIS TESTIMONY ON THE ISSUE OF U.S. METRIC TRANSITION AND THE VITAL ROLE PLAYED IN IT BY THE OFFICE OF PRODUCTIVITY, TECHNOLOGY AND INNOVATION (OPTI) OF THE DEPARTMENT OF COMMERCE.

ANMC IS THE PRIVATE SECTOR FOCAL POINT FOR INFORMATION, PLANNING AND COORDINATION OF THE U.S. METRIC CHANGEOVER PROCESS. OUR MEMBERSHIP INCLUDES 500 SUBSCRIBERS FROM LARGE AND SMALL BUSINESS, TRADE ASSOCIATIONS AND PROFESSIONAL SOCIETIES, EDUCATORS, CONSUMERS, AND GOVERNMENT AGENCIES WITH AN INTEREST IN METRIC TRANSITION AS A MEANS TO ENHANCE U.S. INTERNATIONAL TRADE AND PRESERVE AMERICAN JOBS. WE REPRESENT 10% OF THE FORTUNE 500 INDUSTRIAL CORPORATIONS, AND 40% OF THE LEADING 50 U.S. EXPORTERS WITH OVER $400 BILLION IN ANNUAL SALES AND EMPLOYING 4½ MILLION INDIVIDUALS.

WE SPOKE TO THIS COMMITTEE LAST IN FEBRUARY 1984 IN SUPPORT OF THE METRIC EVALUATION ACT OF 1984 (HR4490). TODAY WE OFFER THIS TESTIMONY IN SUPPORT OF CONTINUED FUNDING FOR OPTI IN THE ADMINISTRATION'S BUDGET FOR FY-86.

THIS IS NOT THE TIME TO DO AWAY WITH THE FEDERAL GOVERNMENT'S FOCAL POINT FOR 3 OF THE MOST IMPORTANT ISSUES FACING THE BUSINESS COMMUNITY TODAY -- IMPROVING OUR PRODUCTIVITY, PRESERVING AND ENHANCING U.S. TECHNOLOGY, AND COORDINATING THE U.S. VOLUNTARY CHANGEOVER TO THE METRIC SYSTEM. OPTI's PRIVATE SECTOR CONSTITUENCY ARE AMONG THE MOST EMBATTLED OF THE AMERICAN BUSINESS COMMUNITY -- THE MANUFACTURER. THEY ARE IN COMPETITION WITH CHEAP FOREIGN LABOR ABLE TO DELIVER A PRODUCT TO OUR SHORES AT LESS COST THAN WE CAN PRODUCE IT AT HOME; A STRONG DOLLAR DRAWS IN IMPORTS WHILE

THE PRICE OF U.S. PRODUCTS INCREASE OVERSEAS. SMALL BUSINESS IS HEAVILY DEPENDENT ON OPTI's RESEARCH INTO THE CONCEPT OF "SHARED FACILITIES" FOR SMALL BUSINESS KNOWN AS FLEXIBLE MANUFACTURING CENTERS. INDEED, OPTI's OFFICE OF METRIC PROGRAMS IS THE CENTRAL COORDINATING POINT FOR THE FEDERAL GOVERNMENT RESPONSIBILITIES UNDER THE METRIC CONVERSION ACT OF 1975 (PL 94-178). WITHOUT OMP, PRIVATE INDUSTRY WOULD HAVE NO PLACE TO TURN TO COORDINATE THE OVER 40 FEDERAL AGENCIES WITH METRIC CHANGEOVER PROGRAMS.

IN 1982 THE U.S. METRIC BOARD WAS PHASED OUT OF OPERATION AS PART OF THE ADMINISTRATION'S PROGRAM TO REDUCE GOVERNMENT SPENDING. THE FEDERAL RESPONSIBILITY FOR METRIC ACTIVITY WAS THEN GIVEN TO THE U.S. DEPARTMENT OF COMMERCE. THESE ACTIONS WERE VIEWED BY THE MEDIA AND THE GENERAL PUBLIC AS A LACK OF INTEREST IN METRIC USE BY THE GOVERNMENT. ANMC IS SERIOUSLY CONCERNED, THAT IF WE NOW 3 YEARS LATER PHASE OUT OPTI, THIS WILL AGAIN SERIOUSLY DETER THE U.S. VOLUNTARY TRANSITION TO USE OF THE METRIC SYSTEM. THERE IS A NEED FOR A FEDERAL FOCAL POINT, FOR METRIC ISSUES SIMILAR TO TASKS THAT WE IN ANMC DO FOR THE PRIVATE SECTOR. THERE ARE MANY AREAS DEMANDING THE ATTENTION OF OPTI, AND OMP IN GUIDING THE GOVERNMENT'S METRIC POLICY.

--THE DEPARTMENT OF DEFENSE IS MOVING STEADILY TOWARD METRIC CHANGEOVER FOR INTEROPERABILITY WITH OUR NATO ALLIES.

--INTERNATIONAL WEATHER MAPPING, DATA EXCHANGE, AND SPACE EXPLORATION ARE OTHER EXAMPLES WHERE METRIC USE IS STEADILY INCREASING.

--THE PRIVATE SECTOR NEEDS A PLACE TO TURN TO DETERMINE METRIC REQUIREMENTS IN OVERSEAS MARKETS.

--THERE IS A NEED FOR OPTI TO COORDINATE AMONG FEDERAL AGENCIES TO PROMOTE CONSISTENCY, IN THEIR PLANS, POLICIES AND PRACTICES SO THAT NO ARTIFICIAL BARRIERS ARE PUT IN THE WAY OF VOLUNTARY METRIC TRANSITION IN FEDERAL LAW, REGULATION CODES, STANDARDS AND REGULATIONS.

THE METRIC SYSTEM IS THE WORLD'S MEASUREMENT LANGUAGE FOR TRADE AND SCIENCE AND IS ONE PART OF THE ANSWER TO OUR BALANCE OF TRADE PROBLEMS. IT IS VITAL THAT THE U.S. ENHANCE ITS INTERNATIONAL TRADE AND COMPETITIVENESS. OPTI IS IN PLACE AND ASSISTING IN THIS EFFORT; TO TERMINATE ITS ACTIVITIES WILL SEND U.S. INDUSTRY AND OUR TRADING PARTNERS THE WRONG MESSAGE.

THE AMERICAN NATIONAL METRIC COUNCIL APPRECIATES THE OPPORTUNITY TO TESTIFY IN SUPPORT OF THE OFFICE OF PRODUCTIVITY, TECHNOOGY AND INNOVATION OF THE DEPARTMENT OF COMMERCE, AND URGES THE COMMITTEE TO CONTINUE ITS SUPPORT OF THE U.S. VOLUNTARY METRIC TRANSITION PROCESS AS ONE VITAL ELEMENT IN ENHANCING THE ABILITY OF U.S. PRODUCTS IN THE INTERNATIONAL MARKET PLACE.

HARVARD UNIVERSITY
CENTER FOR RESEARCH IN COMPUTING TECHNOLOGY

March 14, 1985

The Honorable Douglas Walgren
Chairman
Subcommittee on Science, Research
and Technology
Rayburn HOB, Room # 2319
Committee on Science and Technology
U. S. House of Representatives
Washington, DC 20519

Dear Congressman Walgren:

Thank you for the opportunity to submit, for the record, my views on ICST and its invaluable role in helping to meet the public interest. I appreciate the fact that your committee's hearing schedule could not accommodate all of us who are interested in speaking on behalf of the Institute for Computer Science and Technology.

A copy of my CV is enclosed. The position I hold at Harvard was designed to provide a bridge between the academic world of computer sciences and the real world of the high technology industry. Thus, I am perhaps specially qualified to comment on ICST's role in meeting real public needs.

If there is a way I may be of further service, please do not hesitate to call me.

Sincerely,

Ugo O. Gagliardi
Gordon McKay Professor
of the Practice of
Computer Engineering

AIKEN COMPUTATION LABORATORY
Cambridge, Mass. 02138

STATEMENT FOR THE RECORD SUBMITTED TO THE SUB-COMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY, CHAIRMAN: DOUGLAS WALGREN.

INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY/NATIONAL BUREAU OF STANDARDS

Ugo O. Gagliardi, Gordon McKay Professor of the Practice
of Computer Engineering, Harvard University;
President, General Systems Group, Inc.

Thank you for giving me the opportunity to put my observations about ICST on the record. Before I begin, it would probably be useful to tell you who I am and explain my relationship to ICST. Since 1966, I have been a member of the Harvard faculty, teaching courses in Computer Sciences. Concurrently I have held a number of positions in the computer industry, as follows: 1968 to 1970 - Director of Technical Operations, Interactive Sciences Corp.; 1970 to 1975 - Director of Engineering for Honeywell's Boston Computer Operations; 1975 to present - President of General Systems Group, Inc.

In the late 70s, shortly after ICST received sufficient funding to perform its Congressionally mandated functions, the new management invited me to serve as a consultant to review its programs annually. I was asked to help to insure that ICST activities were based on "real world" requirements. In that capacity, I have assessed ICST's programs a number of times. I am familiar with both the goals and the staff. I have watched ICST evolve from a state of ineffectiveness into a competent, technical organization which is respected in the computer field.

It is true that, for many years, ICST was at odds with the computer industry. In fact, at one time, a group of major manufacturers had taken ICST to court in a dispute over its Input/Output Interface Standard. The companies maintained that ICST was a regulatory agency and had not operated under due process of law. The Courts, including the Supreme Court, ruled that ICST was not a regulatory agency and had acted within its legal purview. The new ICST management had concluded, however, that continued friction with the computer industry was not in the best interests of the nation. It set for itself the goal of continuing to support the public interest, but in ways which would allow the high technology industry to maintain its competitive edge in the world marketplace.

Prof. Ugo O. Gagliardi's statement for the record, submitted to the Subcommittee on Science, Research and Technology on behalf of the ICST/NBS

As ICST grew and matured, there was mounting evidence of both Congressional support and support from the computer industry and significant end-users. Nevertheless, ICST began to come under considerable pressure to maintain its funding at adequate levels. In September 1981, at the beginning of the FY '82 budget cycle, the management of the National Bureau of Standards recommended that ICST's budget be reduced from nearly $13 million to $3 million. Congress disagreed with the NBS decision and restored ICST's budget. NBS made a similar recommendation in FY '83. Again, Congress restored ICST's budget. By FY '84, NBS recognized that ICST had indeed become an effective organization and recommended that it be fully funded. This recommendation was forwarded to OMB. OMB reduced the ICST budget request to $5 million. This time Congress did not restore full funding ($13 million), but did restore the budget to $10 million. The result of this cut was that all major contracting was terminated. In FY '85, NBS recommended that ICST be funded at $10 million. OMB again cut the request to $5 million. When ICST appealed the cut, OMB asked that it furnish additional information.

This annual assault on ICST's budget must be read by the staff as a vote of no confidence by the Congress and higher monitoring authorities in the Executive Branch. This in turn is and will continue to cause significant difficulties in attracting and retaining a high-calibre staff, especially since the computer industry has an over abundance of job opportunities for qualified people. Indeed, recently I have begun to see an erosion of staff morale that must inevitably accompany the repeated attacks upon ICST's budget and therefore its future.

I have repeatedly stated to my representatives in Congress (Rep J. Gregg, NH, and Sen. W. Rudman, NH) that ICST serves a crucial function for the computer industry in greatly facilitating the process of emergence of industry standards (especially in the computer networking area). The emergence of such standards is of vital importance to guarantee that the computer industry resists its natural tendency towards excessive economic concentration.

Prof. Ugo O. Gagliardi's statement for the record, submitted to the Subcommittee on Science, Research and Technology on behalf of the ICST/NBS

The safest way to guarantee the independence and impartiality of ICST, in its sensitive and urgently important role, is to keep it as a government funded laboratory. I am, of course, fully aware of the pressing necessity to reduce the government budget. If it is truly not possible for the government to provide full funding of ICST, then I believe the Committee has a responsibility to insure that ICST can continue to function as a private entity in a form that is capable of setting standards for the common good.

I therefore suggest that the Committee explore the possibility of spinning off at least part of ICST's functions to the private sector. The network protocol program is a prime candidate. It (1) has already attracted a great deal of private sector attention and enthusiasm, (2) is a relatively mature program, and (3) has as one of its components -- the testing activities -- an activity which could be set up as a service business.

If such a spin off is to be considered, it is important that steps be taken to insure that the new organization's funding cannot be dominated by one or a small group of manufacturers. If the manufacturers provide exclusive or even primary funding, it will result in attempts to restrict free competition by fostering "proprietary" or quasi-proprietary standards reflecting the product characteristics of the sponsors.

It is therefore essential that the private sector backing for the unit come from end-users (including Government agencies) rather than exclusively from vendors. The entity that is assigned responsibility for the program should be required to demonstrate that, after a limited transition period, it will be driven by end-users. At best, all of the financial support should come from the end-users; a second, less desirable alternative is that a major portion of the funding should come from end-users. Under no circumstances should the manufacturers be allowed to dominate the funding.

Prof. Ugo O. Gagliardi's statement for the record, submitted to the Subcommittee on Science, Research and Technology on behalf of ICST/NBS

It should be recognized that there are other government computer-related standardization programs which may become candidates for spin-off within the next few years, too. A particularly good example is DOD's validation program for the Ada language. Should a private sector organization be established for some of the ICST programs, care should be taken to create a structure that can evolve painlessly to accept other spin-offs as similar programs mature.

Thank you again for permitting me to place my observations on the record.

Ugo O. Gagliardi

UGO O. GAGLIARDI was born in Naples, Italy, received a Diploma in mathematics and physics in 1951, and Dr. Ing. degree in 1954, both from the University of Naples. He then became an instructor in Electrical Engineering at his alma mater, leaving for a Fulbright Scholarship at Columbia University in New York in 1955. From 1956 to 1961, Prof. Gagliardi was first Assistant Professor and then Associate Professor of Electrical Engineering at Kansas State University, from whence he joined the staff of Dunlap & Associates of Darien, Connecticut, an R&D firm specializing in military manned computer systems, serving there between 1961 and 1965 in a number of positions the final one being that of the Chief Scientist for the firm's Systems Engineering division. Prof. Gagliardi served as the computer graphics section chief at the USAF Decision Sciences Laboratory in Bedford, Massachusetts from 1965 to 1966. From 1966 to the present, Prof. Gagliardi has been on the faculty at Harvard University, teaching graduate courses in software engineering, computing systems architecture, operating systems and data base design. He was named Professor of the Practice of Computer Engineering in 1974, and Gordon McKay Professor of the Practice of Computer Engineering in 1983. Since 1966, concurrent with his duties at Harvard, he has served as VP of Technical Operations for Interactive Sciences Corp., Braintree, Massachusetts; Director of HIS Technical Office and Director of Engineering, Boston, Computer Operations, Honeywell Information Systems, Inc., Waltham, Massachusetts. where he directed as Chief Architect the development of the Series 60 product line of Honeywell Information Systems. In 1975, Prof. Gagliardi founded General Systems Group, Inc., a company he heads to this day. GSG, Inc., is a Boston/Washington based, engineering firm specializing in the design, implementation, installation and operation of information processing systems for industry and governments.

CURRICULUM VITAE

UGO O. GAGLIARDI

EMPLOYMENT HISTORY

GENERAL SYSTEMS GROUP, Inc., Salem, NH 1975 - Present

President

Responsible for overall company performance, growth, policies, and standards. Responsible for the technical direction of a number of GSG projects.

GSG, Inc. is an engineering firm specializing in the design of information processing systems for industry and government, and in the management and review of the implementation, installation and operation of such systems.

Current/recent (last two years) projects directed by Dr. Gagliardi include:

System design of a large (several thousand computers) distributed network of minicomputers and microcomputers used by a European banking association in a transaction processing mode. The system design was done to understand the causes for severe performance problems exhibited by the initial implementation of the system.

The system design uncovered the following specific problems:

a) Insufficient real memory in the network control processors caused severe virtual memory thrashing with a total collapse of the performance (response time and throughput) of the network nodes.

b) The lack of any mass storage at the intelligent terminals of the system resulted in excessive traffic from the network nodes to the terminals.

c) The segmentation structure of the application programs was ill-suited to minimize demand on main memory.

d) The software architecture of a universal programmable multi-line controller resulted in excessive overhead and a significant reduction of the effective communication capacity (bandwidth) of the system.

Rev. 10/82

These findings resulted in a major redesign of the system which, when implemented, demonstrated acceptable performance.

Assessment of the hardware/software architecture of a new minicomputer produced by an American vendor. The assessment was done by coupling to a design review, a controlled experiment utilizing a parameterized transaction processing application developed by GSG. The assessment uncovered the following specific problems:

a) The telecommunication processing hardware/software architecture was wrong in the sense of forcing an excessive amount of character and field interrupt processing at the CPU level. The result of this condition was that the CPU would reach queueing saturation (very long response times) conditions with too low a number of terminals to make the product economically viable in the transaction processing market.

b) The process management architecture of the OS was optimized for an application environment involving few, infrequently switched user processes. Transaction processing requires many, frequently switched processes.

c) The architecture of the disk controller had insufficient parallelism and thus could not sustain the disk access rate required by an economically viable number of terminals doing transaction processing.

d) The software architecture of the transaction handler package handled distinct transactions units via a multi-tasking environment (as opposed to separate processes) which provided insufficient protection against damage inflicted by a faulty transaction unit on any of the others.

The findings of this study had a very significant impact on the development activities of this vendor.

Review, assessment and preliminary system design of the Source Data System (SDS) RFP issued by the Department of the Navy.

SDS is a predominantly transaction processing system to be used by the Navy at over 150 personnel field offices and involving in excess of 2,000 field terminals.

The review, assessment and preliminary system design revealed the following problems with the implied system design and architecture:

a) The strong suggestion of a limitation to using dumb terminals will result in a number of the CPUs entering queueing saturation because of excessive field processing workloads.

b) The centralization of processing power in 19 sites will result in excessive communication costs, excessive congestion of the processing nodes, and very poor response time.

c) The data characterizing the expected workload in number of terminals per field office, and transaction/hour rates showed very poor statistical dependability making it a questionnable basis for design.

d) The RFP did not supply sufficient information regarding the type of data sets required by the application (record layouts, sizes, constraints on geographic distribution) to allow the system design to correctly trade-off distribution of the data sets versus communication costs.

e) Not sufficiently stringent performance requirements (response time and throughput) were levied against the vendors to insure that proposed designs would deliver acceptable performance under peak load conditions.

Review of the system and architecture design of a network service offering by a major American corporation.

The system in question would allow private corporations to implement their geographically distributed order processing, catalog services, inventory control, etc. processes using the hardware and system software plant of this vendor.

The review in question resulted in no major technical/design problems; however, the following specific product planning or business problems were unearthed:

a) The product planning assumptions regarding the transaction per hour rate were too low leading to the false conclusion that a very high number of terminals could be supported with excellent response time. This, in turn, translated into false assumptions regarding the pricing of the service.

b) Marketing plans had underestimated in a major way, the number, quality, and specialized training required of technical support specialists. Our finding indicated that these specialists would be the bottleneck resource in insuring the rapid nation-wide spread of the proposed service.

c) Product planning assumptions, regarding the degree of compatibility required by the offered application programming languages, were inadequate to insure conversion of users with significant application portfolios to the service.

d) The operational concept of the proposed service unnecessarily restricted the freedom of customers in developing their own custom applications. This was due to a poor understanding on the part of the product planners of the very effective protection and insulation mechanisms provided, by state-of-the-art operating systems, to each application program against misbehavior of other application programs.

This review had a significant impact on the business plans for this offering.

In addition to the above projects under his direction, Dr. Gagliardi routinely contributes technical advice to numerous projects in the firm.

HARVARD UNIVERSITY, Cambridge, MA 1966 - present

Gordon McKay Professor of the Practice of Computer Engineering

Teaching of graduate courses in software engineering, computing system architecture, operating systems design, and data base design.

Research and PhD thesis supervision in systems performance modelling, virtual machines design and theory, data base organization and performance.

The research performed by Dr. Gagliardi and his students has resulted in numerous vital contributions to the computing field. Some of the most important ones are:

- A theory of congestion for computing systems. This theory allows modelling workload induced traffic in computing systems under realistic assumptions. The models are computationally very efficient and accurate.
- An unification of the memory management field via the introduction of control theoretic concepts. The practical meaning of this work is that it becomes possible to design operating systems which will select the optimum page replacement policy.
- A generalization of the balanced binary trees, used in modern file structures, to accommodate multiple preferred sorting sequences. It is expected that these results will greatly aid the cost/effective implementation of relational data base management systems.

Out of twenty-eight theses published by Garland Publishing, Inc., as part of the series on Distinguished PhD Thesis in Computer Sciences, three are by students of Dr. Gagliardi and one is by a student of a student of his.

Rev. 10/82

HONEYWELL INFORMATION SYSTEMS, INC., Waltham, MA 1970 - 1975

Director of Engineering, Boston Computer Operations 1970 - 1973

Had direct line responsibility for about one-third of the total corporate development effort comprising the development of a major central processor, several I/O processors, several compilers, a major data management system and many utilities.

Director HIS Technical Office (HISTO) 1970 - 1975

Technical direction of HIS series 60 product line development.

The total R&D effort comprised hardware/software engineering efforts in four countries involving the development of several central processors, I/O processors, two major operating systems, a number of emulators, conversion utilities, several major compilers, data management systems and utilities.

Responsibilities included:

Chairing the HIS Architecture Committee, which was responsible for all the major product line architectural decisions. Final review and approval sign-off on all company-wide specifications and standards (hardware and software).

Steering the internal software standardization effort to insure product line compatibility and proper relation of internal standards to industry standards.

Periodic project reviews of the various hardware and software elements of the product line.

Supporting the corporate business planning function with assessment of competitive moves, new technology (hardware and software) business potential, and business implications of positions developed by national and international regulatory and standardization bodies.

INTERACTIVE SCIENCES, CORP., Braintree, MA 1968 - 1970

Vice President, Technical Operations

Responsible for the following:

The development of the customized Operating System for this time-sharing vendor. Development efforts conducted included:

The development of a file management system that fully exploited the modularity of disk-pack devices so to allow sustaining massive damage while still allowing user access to undamaged sections of the file system.

Development of the concentrator and communication network systems for the company.

Responsible for the time-sharing operations and staff.

HARVARD UNIVERSITY, Cambridge, MA 1966 - 1968

(See above)

USAF, DECISION SCIENCES LABORATORY, Bedford, MA 1965 - 1966

Section Chief

Headed a group of computer graphics experts in a research project that resulted in the development of a very powerful array oriented problem solving language which took full advantage of the very versatile computer display hardware available at the laboratory.

DUNLAP & ASSOCIATES, Darien, Conn. 1961 - 1965

Chief Scientist

System Division:

Involved in R&D for several military man-computer systems to support tactical and logistic decision making.

Rev. 10/82

KANSAS STATE UNIVERSITY, Manhattan, Kansas 1956 - 1961

Associate Professor of Electrical Engineering

Taught graduate level courses in the following:

Linear algebra, network theory, logic design, and servomechanisms.

Research and PhD thesis supervision in pattern recognition and the theory of error detecting and correcting codes.

(See Education Section) 1955 - 1956

UNIVERSITY OF NAPLES, ITALY, Naples, Italy 1954 - 1955

Instructor in Electrical Engineering

Did research in the application of analog computer techniques to the control of power generation and distribution systems.

EDUCATION

Fulbright Scholar, Columbia University, New York 1955 - 1956.

Dr. Ing. (E.E.), University of Naples, Italy 1954

Diploma Mathematics & Physics, University of Naples, Italy 1951

PROFESSIONAL ACTIVITIES

Technical Area Director AFIPS National Computer Conference (NCC) Anaheim, California, May 1975. Area: "Impact of New Hardware Technologies on Systems Architecture".

Session Chairman AFIPS National Computer Chicago May 1974. Session on "Improving Computer System Effectiveness".

Panel Chairman: Architecture Panel, tri-service workshop on "The High Cost of Software" Naval Postgraduate School, Monterey, California, September 17-19, 1973.

Rev. 10/82

Session Chairman AFIPS National Computer Conference (NCCEE) New York, June 4-8, 1973 Session on Virtual Computer Systems.

Workshop Chairman Session on Architecture Principles ACM Workshop on Virtual Computer Systems March 1973.

Session Chairman Session on Measurement and Performance Evaluation ACM Workshop on System Performance Evaluation April 1971.

Workshop and Program Co-Chairman ACM SIGOPS Workshop on System Performance Evaluation 5-7 April 1971, Harvard University.

PUBLICATIONS

U. O. Gagliardi, "Software, What is it?", invited paper for a special issue on software of the Journal of the American Patent Lawyers Association, 1980.

U. O. Gagliardi, "Trends in Computing Systems Architecture", invited paper for special issue of IEEE Computer Transactions, June 1975.

U. O. Gagliardi, "Software-Related Advances in Computer Hardware", ACM SIGARCH Computer Architecture News, Vol. 3, No. 2, June 1974, pp. 12, 36.

U. O. Gagliardi and J. P. Buzen, "Introduction to Virtual Machines", Honeywell Computer Journal 7, Nov. 4, 1973.

U. O. Gagliardi, "Chairman's Report of the Architecture Panel Recommendations", tri-service workshop on "The High Cost of Software", Naval Postgraduate School, Monterey, California, September 17-19, 1973.

U. O. ~~Gagli~~ardi and J. P. Buzen, "Research Analysis of Operating Systems", Air Force Technical Report ESD-TR-73-274, Deputy for Command and Management Systems, H. Q. Electronic Systems Division (AFSC), L. G. Hanscom Field, Bedford, MA, October 1973.

U. O. Gagliardi and J. P. Buzen, "The Evolution of Virtual Machine Architecture", proceedings of the AFIPS NCCEE, June 4-8, 1973, New York.

Rev. 10/82

U. O. Gagliardi, "The Fourth Generation International Computer State-of-the-Art Report #1 Infotech, Ltd. "Book Review IEEE Transactions on Computers", December 1972, Vol. C-21, pg. 1459.

U. O. Gagliardi and R. P. Goldberg, "Virtualizeable Architecture" ACM, AICA International Computing Symposium Proceedings, Venice, Italy, April 1972, pp. 527-438.

U. O. Gagliardi, "System Performance Evaluation", Ed. Proceedings ACM Workshop on Performance Evaluation, April 1971.

U. O. Gagliardi, "A Bayesian Viewpoint in the Evolution of Information Systems", Journal of the Japanese Society of Operation Research, 1965.

U. O. Gagliardi, "A Decision Theoretic Model of the Acquisition and Threat Evaluation Functions of BMEWS", ESD-TDR-65-415, August 1965.

U. O. Gagliardi, "A Decision Theoretic Evaluation of an Idealized Bomb Damage Assessment Information System", 27th Operation Research Society of America Meeting, Methods and Applications of Decision Theory, Boston, May 1965.

U. O. Gagliardi, "Two Extensions of Decision Theory", ESD-TR-65-216, January 1965.

U. O. Gagliardi, C. G. Ying, L. G. Holt, "Mathematical Programming Techniques for Information System Design", ESD-TDR-64-530, July 1964.

SMALL BUSINESS PRODUCTIVITY

For many decades, the Department of Commerce has been viewed by many as representing the interests, primarily, of big business. The Small Business Administration was created, in part, to provide representation for the small business community and to provide assistance to small business which had not been available previously within the Department of Commerce, notwithstanding the existence of agencies and offices within the Department of Commerce which purported to be of assistance and guidance to small business.

The current Administration created within the Department of Commerce the Office of Productivity, Technology, and Innovation (OPTI) under an Assistant Secretary, which has provided the needed impetus to small business growth and development options which inure to the benefit not only of small business, but to the favorable development of the U. S. economy in general. The abolition of OPTI and its related activities will provide a void which no other section of the Executive Branch is equipped to fill.

Rather than dissolution of OPTI, it should be given the additional role of coordination of the Small Business Innovation and Research (SBIR) activities, now implemented individually and uncoordinated by the various agencies in the Administration. It should be encouraged to continue its research into the concept of "shared facilities" for small business known as "flexible manufacturing" centers, and similar concepts which are vital to the strength of the economy and even the survivability of the U. S. in a longer range context. It must ensure the continuation of the Office of Metric Programs (OMP), since the problems of metric transition to the universal world measurement system (SI) is a problem primarily of the small business community (which has yet to feel the impact in trade) and not the large multinational businesses, which have or are converting unilaterally to the metric system, which a small business generally cannot do.

RESOLVED:

> The Congress be encouraged to preserve and provide not less than current funding for the Office of Productivity, Technology and Innovation of the Department of Commerce, as presently constituted under current or other name, at the Assistant Secretary level.

SOURCE: National Small Business Association

datron

April 8,1985

APR 11 19

Honorable Douglas Walgren
Chairman
Sub-Committee on Science, Research and Technology
The Hart Senate Office Building
Room 2441 RHOB
Washington, D.C. 20515

Dear Congressman Walgren:

This letter is being offered as written testimony on behalf of the U.S. National Bureau of Standards.

I would like to bring to the attention of your Committee my feelings concerning the position of the United States National Bureau of Standards as compared to other National Standardizing Laboratories throughout the world in the area of research and development, specifically concerning advancement of the "State of the Art", the highest level of technology in the world.

At the current time, I am the President of Datron Instruments,Inc., a manufacturer of test and measurement equipment including electronic calibration standards. I have personally been in this industry since 1960 and have been involved with NBS and most of the major National Laboratories throughout the world. I have had the opportunity to see how other countries function in the area of National Standards and their relationship with their nation's industries. I would like to point out that over the past 25 years, the United States has made very few contributions to the International Metrology community. At the present time, the United States National Bureau of Standards is maintaining many of our nation's electrical standards with instrumentation utilizing "State of the Art" technology which has been developed by National Laboratories of foreign countries. I would like to highlight some of the more important developments in electrical measurement techniques that have occurred over the past number of years. Most of the advances in the "State of the Art" come from the work of experimenters in establishing and maintaining the units in the National Laboratories. It appears that NBS has picked up on the ideas and developments of other laboratories and further enhanced their use, but in the true sense of research and development, NBS appears to trail behind other National Laboratories and come up with new ideas.

Examples of these follow:

The International Unit of Resistance and capacitance including parameters which are maintained at the National Bureau of Standards are based upon the computable capacitor. This theory and original work was discovered by Thompson and Lamphart of the Australian National Laboratory.

The Current Comparative principle which is now used at the National Bureau of Standards to maintain the National Unit of Resistance was developed by Kusters and Moore of the Canadian National Research Council. Current comparator instrumentation was the basis for maintaining AC Standards of Ratio, DC Standards of Voltage and Resistance. NBS felt that this development was significant that it set up a separate group within the Bureau to study and further develop the current comparator principle.

In the field of AC Inductive Dividers, J.J. Hill of the British National Laboratory pointed the way to do AC Resistance Thermometry employing these dividers. Here too, the Bureau has picked up on this idea and further enhanced it.

In the field of Resistance Standards the device commonly known today as the Hammon Transfer Standard was developed by the Australian National Laboratory. Here again, NBS picked up on this idea.

In the area of AC/DC Transfer Measurements, the United States led the way for many decades, but, about twenty years ago, the concept of the multijunction thermal converter was produced by work originally carried out in the National Laboratories of the USSR and Great Britain. These devices which were manufactured in Canada are presently being used by NBS as our nation's standards.

More recently, in the area of the absolute determination of the Ohm, it appears work being done by the German National Laboratory will be the new International Determination of the Ohm.

In the area of energy measurements which is of great concern to most of the world and work being done in Japan and in Canada seems to be the best being accomplished today.

As far as R&D here in the United States, in the area of electrical units and National Standards, one of the contributions made by U.S. industry and here again, picked up by NBS was the work done on the DC Josephson's Junction which involves the unit of voltage; this work was carried out at the University of Pennsylvania and now is being used as the U.S. Legal Volt and also throughout most of the International Metrology community.

In addition to not being at the forefront of technology in this area, NBS fees for calibration service are the highest in the world and in many cases the charges are disproportionate to the original cost of the product being calibrated, i.e., a standard resistor can be purchased for $510.00 from the manufacturer and which includes a calibration. If this same resistor is simply recalibrated by NBS the cost is $374.00. This cost is 73% of the original purchase price.

In summarizing the above, it is evident to someone who has been in this industry for almost two and a half decades that the United States seems to lack initiative and the funds to develop new standards.

It is imperative that NBS be given funds to enable the United States to become a dominant factor in the field of International Metrology.

Very truly yours,
DATRON INSTRUMENTS, INC.

Edward Nemeroff
President

APPENDIX II

NFPA
National Forest Products Association
Forest Industries Building / 1619 Massachusetts Avenue, N.W. / Washington, D.C. 20036

Scott Shotwell
Vice President
Congressional Relations
202-797-5845

March 25, 1985

The Honorable Doug Walgren
Chairman
Subcommittee on Science, Research and Technology
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

In our letter of March 12, 1985, the National Forest Products Association recommended continuation of the beneficial work of the National Bureau of Standards Center for Fire Research (CFR). The following specific information is provided in further support of that position.

It is the general view of the National Forest Products Association that basic fire research performed by the CFR is needed to provide a rational approach to national fire regulations and as a background for required fire research studies. The CFR is recognized as the world leader in development of mathematical fire models and computer simulation. As a result of this work, it is now possible to predict, through modeling, the spread of smoke, toxic gases and heat from a fire in a room to other parts of a building. These techniques will establish the basis for improved fire safety while providing designers, builders and regulatory authorities with the capability to provide the necessary fire safety at reduced cost with greater design flexibility. This work is in its infancy and should be continued.

Concerns with combustion (smoke) toxicity in fires have surfaced in many states throughout the country. The CFR has developed a test procedure for measuring combustion toxicity of materials. This methodology has received wide recognition in the scientific community and is presently undergoing review in the American Society for Testing and Materials. It is important that this effort be continued.

CFR has also been the leader in the development of a test method for measuring rate-of-heat release. This concept is of special significance to the building industry since it determines the rate at which a material actually contributes heat to a fire. This association, through the Research Associate Program at the National Bureau of Standards, participated in developing a heat release test method. This work contributes to the success of the fire modeling program and should be continued.

These examples of current and ongoing work at the Center for Fire Research, in our view, clearly support the need for funding continuation of the Center for Fire Research at the National Bureau of Standards. We urge your support.

Sincerely,

Scott Shotwell

NFPA
National Forest Products Association
Forest Industries Building / 1619 Massachusetts Avenue, N.W. / Washington, D.C. 20036

Scott Shotwell
Vice President
Congressional Relations
202-797-5845

March 12, 1985

The Honorable Doug Walgren
Chairman
Subcommittee on Science, Research
and Technology
2321 Rayburn House Ofc. Bldg.
Washington, D.C. 20515

Dear Mr. Chairman:

The National Forest Products Association (NFPA), a federation of lumber and wood products associations, supports the activities of the National Bureau of Standards (NBS) Center for Fire Research and is concerned that authorization for its continuing work is not included in the Administration's proposed fiscal 1986 budget.

The goal to reduce fire fatalities and fire loss in the United States is very significant to the industry and has been endorsed by many members of Congress. Much of the necessary basic fire research to address this issue on a national basis is underway or contemplated at the Center for Fire Research.

Many wood and non-wood building material manufacturers are involved in research on fire performance of their products. Regulatory acceptance of these products is based upon national fire performance and test standards. Such standards are dependent upon credible basic research and evaluation provided by the Center for Fire Research as an essential service to the regulatory and scientific community. Development of quantitative tools for fire safety prediction and evaluation, including new computer methodology, is the unique contribution of the Center for Fire Research. It would be costly and lacking in credibility for different segments of the industry to attempt to replicate the work of the Center.

The National Forest Products Association is strongly supportive of efforts to control federal spending; however, the activities of the NBS Center for Fire Research are of such a priority nature that they should be continued through a reallocation of budgeted funds.

We respectfully request that our statement be incorporated into the record on the fiscal 1986 budget request for the National Bureau of Standards.

Sincerely,

Scott Shotwell

**The Society of the
Plastics Industry, Inc.**

605 14th Street, N.W.
7th Floor
Washington, D.C. 20005
(202) 628-0270

February 26, 1985

Honorable Doug Walgren, Chairman
Science, Research and Technology Subcommittee
Committee on Science and Technology
2319 Rayburn House Office Building
Washington, D.C. 20515

Dear Representative Walgren:

I am writing to express the concern of the plastics industry over the Reagan Administration's proposed elimination of funding in its 1985-86 budget for the Center for Fire Research (CFR) at the National Bureau of Standards. As you know, the proposal has been made in past years and the House Science and Technology Committee has consistently taken the lead in restoring CFR funding. The Society of the Plastics Industry urges you in your capacity as Chairman of the Subcommittee on Science, Research and Technology to support continuation of the CFR in 1985-86 and beyond.

A recurring theme in past reauthorization hearings has been that the federal government should not be involved in applied research, its more proper place being addressed by the private sector. The Society of the Plastics Industry has a long history of involvement and interest in the cause of fire safety. As the principal trade association for an industry that includes major manufacturers of furnishings and building materials, our members are actively involved in extensive research to develop products with improved fire safety characteristics. Although considerable fire technology research is conducted by industry and independent institutions, the CFR possesses a unique research capacity and experience that cannot be duplicated elsewhere and which has greatly advanced our understanding of the complex phenomena of fire.

Current efforts by CFR in such vital areas as total fire hazard analysis are creating breakthroughs in advancing our understanding of fires and how to minimize their dangers to life and property. The elimination or curtailment of its important work would be a serious setback for fire safety in the United States.

If our industry can provide you or your subcommittee colleagues any additional information or views, we would be happy to do so.

Sincerely,

Lewis R. Freeman, Jr.
Vice President, Government Affairs

LRF/pko

[illegible]
CFR
P # [illegible]

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COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING

BERKELEY, CALIFORNIA 94720

March 13, 1985

Honorable Don Fuqua
Chairman, Committee on Science, Research and Technology
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Congressman Fuqua:

May I ask you once again for your assistance in saving many lives, avoiding uncountable heinous injuries and preventing future disasters?

It is inconceivable to me that the United States, whose national fire loss record is already one of the worst in the world, would choose to become the only major civilized nation without a national fire center. And yet the current budget proposal does precisely that - it terminates the Center for Fire Research at the National Bureau of Standards within the Department of Commerce.

The Center is the worldwide leader in fundamental fire research with an excellence level truly unusual in government or university research centers. The Center povides a focus for fire related research and application activity throughout the United States and, indeed, the world. Without this focus, our life and property losses to fire would.assuredly climb exponentially. There will also be serious consequences to national and civil defense. Now, when the Center is beginning to have a real practical impact, is precisely the wrong time to destroy it.

This is a technical question. Please note my professional opinion that proper fire safety assessment is at the very forefront of combustion research. No local agency, nor private company has, nor can it afford to obtain, the competence required to replace this Center.

I too am concerned about high government budget deficits. But this is false economy. The "saving" of the Center's yearly budget of 5 million dollars does not bear the scrutiny of cost-benefit analysis.

Please vote to restore the Center for Fire Research to last year's level of support in this year's budget. I thank you and future generations will thank you.

Sincerely,

P. J. Pagni

Patrick J. Pagni
Professor

RECEIVED
[illegible]
COMMITTEE ON SCIENCE
AND TECHNOLOGY

pjp/ceg

U.S. CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, D.C. 20207

April 2, 1985

The Honorable Douglas Walgren
Chairman
Subcommittee on Science, Research and Technology
Committee on Science and Technology
U. S. House of Representatives
Washington, D. C. 20515

Dear Mr. Chairman:

In response to your telephone inquiry to our Office of Congressional Relations, regarding the Consumer Product Safety Commission's reliance on the Center for Fire Research at the National Bureau of Standards (NBS), I am pleased to provide the following information.

Section 29(d) of the Consumer Product Safety Act states: "The Commission shall, to the maximum extent practicable, utilize the resources and facilities of the National Bureau of Standards, on a reimbursable basis, to perform research and analyses related to risks of injury associated with consumer products (including fire and risks from flammable fabrics), to develop test methods, to conduct studies and investigations, and to provide technical advice and assistance in connection with functions of the Commission."

The Commission has worked productively with the Center for Fire Research (CFR) since CPSC was activated in 1973. The areas of cooperation over the years are: Toxicity of Combustion Products, Upholstered Furniture Flammability, Fire Growth Research, Heating Equipment and the Cigarette Safety Act of 1984. The CFR has also advised the Commission on smoke detectors, smoke masks, mattress and apparel flammability, and fire data analyses. This relationship has been both productive and beneficial.

I hope this information is helpful. Please let me know if you have any further questions.

Sincerely,

Terrence Scanlon

Terrence Scanlon
Chairman

CASE WESTERN RESERVE UNIVERSITY • CLEVELAND, OHIO 44106

Case Institute of Technology

March 18, 1985

Congressman Doug Walgren
2241 Rayburn Building
Washington, D. C. 20515

Dear Congressman Walgren:

The President's budget for Fiscal Year, 1986, proposes the elimination of the Center for Fire Research in the National Bureau of Standards. The rationale is that "this research is more properly the role of the private sector and the state and local government."

I am writing to you to express my deepest disapproval of the proposed elimination of fire research at the federal level. The fire death rate in the United States is one of the highest in the world. The Center for Fire Research is the only comprehensive research program in the United States directed at reducing fire deaths, injuries and costs due to fire. Since its establishment ten years ago, the Center has made tremendous contributions to the understanding of fire science, fire prevention and the education of fire specialists around the country.

Contrary to the statement given by the President, fire research is unlikely to be picked up by the private sector. Fire research, like research on air and water pollution, does not directly generate a profit for private corporations; the chief beneficiary of fire research is the people. So, the federal government should have a direct role.

For a total annual budget of $5.1 million, the elimination of fire research should have a minimal impact on the federal deficit.

Department of Mechanical and Aerospace Engineering
Telephone (216) 368 2940

But, its impact on human life and misery can be enormous. I am, therefore, asking you to use your influence to reverse this proposed elimination of the Center for Fire Research at the National Bureau of Standards.

Thank you very much.

Sincerely,

James S T

James S. T'ien
Professor of Engineering

JST:oam
Enclosure

CENTER FOR FIRE RESEARCH
NATIONAL BUREAU OF STANDARDS

The United States fire death rate is one of the highest in the world (only Canada has a similar fire death rate). The Center for Fire Research is the only comprehensive research program in the United States directed at reducing fire deaths, injuries, and costs due to fire. This research is paying off. Since 1976, the U.S. fire loss record has improved more than any other industrialized nation. Despite this improvement, each year fires result in 7600 deaths, almost 300,000 injuries, and $6.5 billion in direct property losses.

The Center for Fire Research is the world leader in the development of mathematical fire models and computer simulation. These techniques will establish the basis for improved fire safety while providing engineers, architects, building owners and occupants, and code officials with the ability to provide the necessary fire safety at reduced cost and greater flexibility. This work is beginning to bring solid returns. For example, it is now possible to predict the spread of smoke, toxic gases, and heat from a fire in a room to other parts of a building. This permits the prediction of the fire hazard to the building occupants at different locations in the building. These essential tools are just coming into use and represent the beginning of an important transition in fire protection practice. A transition from traditional practices such as costly "build and burn" to the use of scientifically-based models and evaluation tools which when implemented could lead by the end of the century to further reductions in fire deaths of as many as 3,500 lives per year and fire protection costs to society of $15 billion per year.

This transition will require coordinated efforts among both private and public sector institutions in fire protection and research. The Center for Fire Research has initiated this important task of coordination by taking the lead in calling together representatives of the key organizations to a National Fire Research Strategy Conference that will provide the policy guidance and will establish the necessary roles to achieve the needed reductions in fire losses. A first meeting of the Conference has been held and a second is scheduled.

Examples of NBS research that have contributed to reducing the U.S. death rate by over 20% in the last decade are research on smoke detectors, cigarette resistant mattresses and furniture, fire safe children's sleepwear, quick acting residential sprinklers, and fire safety evaluation systems for health care and many other special occupancies. In addition to the in-house research, the Center for Fire Research supports fundamental fire research at about 25 universities and other organizations. The Center provides about $2 million annually, about 1/3 of the appropriated budget, for this purpose.

The NBS Center for Fire Research plays a critical role in underpinning the Federal fire safety effort. The Center is one of three closely coordinated activities created by the Federal Fire Prevention and Control Act of 1974 (P.L. 93-498). The Center provides the broad range of basic research needed to reduce this nation's fire losses. The other two activities are carried out by the United States Fire Administration and the National Fire Academy in the Federal Emergency Management Agency. NBS fire research is also coordinated closely with private sector organizations such as the National Fire Protection Association, the Society of Fire Protection Engineers, and others in the fire protection community.

Termination of the Center for Fire Research would cripple progress towards this goal of reducing loss of life and costs by halting essential basic and applied research, leaving U.S. industry without critical inputs from CFR. The U.S. would then be the only major industrialized nation without a central national fire research effort.

Center for Fire Research
Recent Accomplishments

The Center for Fire Research at the National Bureau of Standards provides the focal point for the nation's research related to fire. The Goal of the Center is:

> TO PROVIDE THE SCIENTIFIC AND TECHNICAL BASIS FOR REDUCING FIRE LOSSES AND THE COSTS OF FIRE PROTECTION BY 50%.

Some recent accomplishments of the Center for Fire Research are:

Fire Safety Evaluation System for Board and Care Homes

CFR has developed a Fire Safety Evaluation System (FSES/B&C) for a relatively new type of occupancy called Board and Care Homes. The number of these homes is growing rapidly and their fire experience has been poor. The project has been completed with the November 1984 vote by the membership of the National Fire Protection Association to include the FSES/B&C in the Life Safety Code.

Smoke and Toxic Hazard Assessment

CFR demonstrated the practicality of calculating the time to reach hazardous conditions as a means for assessing a material's or product's contribution to fire hazard. Smoke toxicity, smoke light obscuration, and temperature were used in the calculations. Such an approach can also serve to put the various hazards from fire into their proper perspective.

Smoke Control Design Manual

CFR, in a joint project with ASHRAE and the VA, developed a smoke control design manual which has been published by ASHRAE. This manual provides engineering design guidelines for building smoke control systems which have become a popular technique of fire protection in large buildings.

Gas and Oil Well Blowout Fires

CFR demonstrated the feasibility of extinguishing or controlling well blowout fires with water sprays. The demonstrated water spray techniques, in addition to their effectiveness, provide the potential for major cost savings over other approaches.

Solid Fuel Heating Appliances

Recent CFR research on wood and coal burning stoves, chimneys, wall protection systems, and wall pass-throughs have resulted in many important improvements in the various codes and standards. Recently completed work on wall protection systems and wall pass-throughs led to a major rewrite of NFPA 211 on Chimneys, Fireplaces, Vents, and Solid Fuel Appliances, and to changes in Underwriters Laboratories' 1482 on Room Heaters, Solid-Fuel Type. The major increase in the use of solid fueled appliances since the early 1970's have led to a large increase in fires and fire deaths due to their use.

Upholstered Furniture Fires

CFR developed the methodology to predict the burning rate of upholstered furniture items from small scale test data. Burning rate is the most important parameter in the determination of the time to hazardous conditions in a fire and also in determining whether a compartment will reach flashover. Previously, the burning rate could be determined only with expensive full scale tests.

Soot in Diffusion Flames

CFR mapped soot precursers in diffusion flames which is a necessary step to developing predictions of the quantitative formation of soot in fire environments. Understanding soot formation is important because it affects visibility, acts as a nucleating site, and is a radiator of energy to room surfaces and objects.

Risk Reduction Potential of Detectors and Sprinklers

CFR developed a demonstration fire risk analysis which provides an estimate of the risk reduction potential of detectors and sprinklers in one and two family dwellings. The analysis is based on the best available data and expert judgment.

Fire Induced Flows

CFR developed a fundamental model to predict fire induced flows. Understanding fluid flow into and out of a fire compartment is necessary to predicting fire growth and the development of hazard.

Fire Safety of Buildings

CFR constructed a prototype method, utilizing fire and smoke models, for evaluating the fire safety of specific buildings. This provides fire protection engineers with guidance and recent computational advances to evaluate fire safety questions.

STATEMENT CONCERNING THE FEDERAL FIRE PREVENTION AND CONTROL PROGRAMS

submitted to the

Subcommittee on Science, Research and Technology
Committee on Science and Technology
United States House of Representatives

by the

National Fire Protection Association
Batterymarch Park
Quincy, Massachusetts 02269

February 7, 1984

Part I

The National Fire Protection Association (NFPA) supports the reauthorization of the Fire Prevention and Control Act of 1974. In providing support for the reauthorization of this Act and the activities of the United States Fire Administration (USFA) and the National Fire Academy, the NFPA provides the following brief background concerning the Association.

The NFPA, founded in 1896, is a nonprofit, technical and educational membership organization. It has remained the principal public advocate for fire safety since its inception. The Asscciation's membership of over 32,000 is drawn from the many disciplines involved in, and concerned about, the national fire problem. NFPA is not a trade or industry association. No one group or interest is dominant. The only common membership denominator is a concern about fire safety. Members include fire service personnel, fire marshals, electrical inspectors and city managers; architects, engineers and educators; health care facility operators and similar groups from commerce, industry, insurance and the Federal Government.

One of the principal functions of NFPA is the development of more than 200 consensus codes and standards related to fire protection. They range from the Life Safety Code through the National Electrical Code, the National Fuel Gas Code and flammable liquids standards, sprinkler and similar equipment standards to those used for fire apparatus, fire fighter safety and professional qualifications. NFPA has many other functions including public education, technical advisory services, research and development, and data collection and analysis.

The NFPA is a founding member of the Joint Council of National Fire Service Organizations (JCNFSO) which has been a prime mover in getting and sustaining a federal focus on fire.

Part II

The NFPA has provided testimony or statements for the record in support of the United States Fire Administration at all of its authorization and appropriation hearings. NFPA has been a strong supporter of the need for the United States Fire Administration and an effective federal involvement in resolving this Nation's fire problems. The NFPA would like to indicate to the Committee its support and approval for the present leadership and direction provided by the Federal Emergency Management Agency. Some of the achievements of the United States Fire Administration are:

- Development of cooperative programs which, in the intent of the enabling legislation, work with existing organizations already well established within the national fire community, taking advantage of the activities of these existing efforts and avoiding duplication.
- In recognition that fire is very much a state and local problem, by supporting and assisting state and local programs in areas for which local resources are limited, or where federal resources are the most effective way to deal with the problem.
- Maintaining the thrust, intent and purposes of the Federal Fire Prevention and Control Act of 1974.
- Placing emphasis on programs dealing with solutions to the everyday community fire problems.

- Continued and highly effective programs of the National Fire Academy and giving these programs the highest priority necessary in relation to the magnitude of the national fire problem. The Academy has always been a major priority with NFPA.

The NFPA desires to compliment FEMA on its recognition of the capabilities of ongoing programs at the state and local level, as well as within the private sector. The Federal Emergency Management Agency has initiated cost-effective, cooperative programs with state and local agencies and other organizations in the true intent of the Fire Prevention and Control Act.

NFPA is encouraged by the direction being taken by the Federal Emergency Management Agency and feels that even more involvement and usage of ongoing programs can ultimately benefit the objectives of the Fire Prevention and Control Act of 1974. As the Nation's principal public advocate for fire safety, the NFPA strongly supports the programs of the United States Fire Administration and the National Fire Academy as provided for in the FY'85 budget under consideration.

Part III

The 1974 Act amended the generic act of the National Bureau of Standards (15 USC 278) to provide for the Fire Research Center at NBS.

We wish to express very serious concern about the future of that establishment. In the Administration's budget for FY '84 there was a zero funding for the Center. Your Committee and the Appropriations Committee restored funds which finally equated the FY '83 level. This was obviously a holding pattern and NFPA greatly appreciated the support Congress gave.

However, the Administration's FY '85 Budget again shows zero funding for the Center for Fire Research and we cannot help wondering how long this fight must continue.

Congress very clearly indicated that fire research by the Center was an important part of the purposes of the Act and necessary to reduce the debilitating effect on the nation's well-being, both in terms of wealth and resources, as well as human suffering.

Since the Act was put into effect, the Center has performed admirably in the role articulated at that time.

The Center has executed many programs of research that have contributed to better control and reduction of the fire problem.

Without going into the litany of these programs, which we submitted to you last year in a lengthy paper on the Center for Fire Research, we would like to point out that scientific and technological research and development has brought means of dealing with the fire problem to us that never were available before.

I refer to the availability of new state-of-art measurement and electronic analysis, which not only enables almost every aspect of fire behavior and the reasons for its erratic and variable growth to be broken down into hitherto unidentifiable components, but also for electronic modeling to be used to provide predictions of fire occurrence, growth, and the effect on materials that could eventually change the whole approach to eradication of fire as a threat by prevention and control.

The Center for Fire Research is at the core of this progress and the possibility of an abrupt end to this is not only appalling but also, in our opinion, criminal. The ripple effect on those outside the Center would be such that academic and scientific fire research work would slow down and possibly stop. The transfer of technology that also stems from the work of the Center would cease.

In an age when research and development is moving ahead in most areas, when we are beginning to see results from new technology in fire control, we fail to see the logic behind the move to eliminate fire research.

We recognize the need for restraint in Federal spending, but when we see lives being lost, hundreds of thousands of disfiguring burns, and billions of dollars of our national wealth reduced to ashes, we find it hard to accept that the 8 to 10 million dollars needed for federal fire research is not worthwhile.

In fact, both in terms of lives saved and property preserved, it is a good investment and certainly will be a cost-effective use of funds.

We have indicated that technology has brought us to the threshold of a new and meaningful attack on the fire problem; we would like to point out just a few examples of key programs of the Center that will lead to very effective solutions:

SMOKE HAZARD ASSESSMENT - This is a multi-faceted program which addresses not only the toxicity of products of combustion but also the movement of the lethal gases in buildings. The CFR work can and will, if continued, ultimately enable a prediction of the hazard in various parts of buildings, even those remote from the immediate fire, and also estimate the time it would take for the building atmosphere to become dangerous to occupants.

The significance of this might not be readily apparent to the layman, but if one recalls some recent fire disasters, it should be easily recognized how critical this information is to building designers, developers, and to code enforcers. And how much more critical it is to those whose lives might be saved by improved design and fire control measures.

FAST-ACTING SPRINKLER SYSTEMS - Over 100 years ago the sprinkler system was introduced and since has more than justified the moderate cost of installation. These systems were generally considered to be for property protection despite the fact that the life safety record in sprinklered buildings has been consistently good.

Recent changes in response time and performance of sprinklers, done mainly to create a low-cost residential system for homeowners, have indicated that the fast-response sprinkler could have a vastly increased life safety role, not only in homes, but any type of occupancy. It might perhaps be the answer to many other fire safety problems. The CFR work on the relationship of the fast-response spinkler to life safety is of vital importance to everyone.

The fact that the technology is now emerging to reduce life loss and materially reduce cost of fire protection at the same time is alone sufficient to justify the continuation of this program.

BUILDING CONTENTS CONTRIBUTION TO FIRE HAZARD - Most safety precautions in fire control have been based on the structure of buildings and in-built protective features. But in almost every fire that occurs, it is the contents of the building that initially ignite and continue to burn creating the smoke and toxic gases that trap and kill the occupants. This has been known for hundreds of years but due to the multiplicity of materials, design, placement and the daily variations that occur in the disposition of contents, it has never been considered very practical to try to cope with this other than in a limited way. With the advent of many new materials, the problem has been compounded.

The CFR is now involved in a program that is expected to lead to methodologies of measuring and modeling contents on a scale that has not been possible before. It should lead to ways of analyzing the effect of building contents when involved in fire that can be translated into practical and applicable formulae for all involved in the design and use of buildings of all categories. There is much work that needs to be done in this area and it is not going to be an easy task but the CFR is the obvious place for the initial research to be carried out.

While these three programs are not the only ones of major importance and that offer solutions, they are good examples of the direction fire research at the Center is taking. These directions are essential, realistic, and are taking full advantage of modern technology. Many of these also involve the Center for Building Technology which has an important and synergistic role with the Center for Fire Research.

We urge that every possible effort be made to preserve and continue the Center for Fire Research and to provide adequate funding for the work that is so necessary to an effective reduction in the United States fire losses.

UNDERWRITERS LABORATORIES INC.
333 PFINGSTEN ROAD · NORTHBROOK, ILLINOIS 60062
an independent, not-for-profit organization testing for public safety

February 29, 1984

The Honorable Doug Walgren
Chairman, Subcommittee on Science,
Research and Technology
Committee on Science and Technology
U. S. House of Representatives
Washington, DC 20515

Dear Mr. Walgren:

The budget proposal sent to Congress by President Reagan includes a total of $126.1 million for the Commerce Department's National Bureau of Standards (NBS), representing a net increase of $10.4 million from the NBS current appropriation of $115.7 million.

My concern is that despite the proposed increase, the Center for Fire Research is scheduled for elimination. If this comes about, a number of programs which represent potentially major breakthroughs in reduction in loss of life and property from fire will be aborted. They will be aborted because the NBS Center for Fire Research has provided the initiatives in terms of testing and data development, scientific analysis, computer programming and information dissemination to the technical community for advancement of these programs.

One of the more important programs is the mathematical modeling of fires. I speak from personal experience in stating that present methods of planning building design for fire safety are cumbersome, limited and expensive. NBS has spearheaded the experimental work and coordination of technical developments which are putting in place a mathematical approach that will substitute for expensive fire testing which yields limited results. This approach is no longer simply a hope of theorists. It will come to fruition, but it will suffer a terrible setback without the Center for Fire Research. I do not know of any organization in the private sector whose scope of interest is sufficiently broad to justify taking on this project.

Look For The UL Listing or Classification Mark On The Product
Phone (312) 272-8800 Telex 72-4336 Cable ULINC Northbrook, Il International Telex No.: 4330173

Another keen area of interest is the issue of deaths resulting from toxic gases generated by unwanted fires. All experts agree that the preponderance of fire deaths results from exposure to toxic gases. Is this problem solvable? Can selective choices of materials used in buildings reduce fire deaths of this type? The answers to these questions involve serious economic consequences to material suppliers and building designers. Consequently, the issue is controversial, emotional and unresolved.

The Center for Fire Research has provided an unbiased forum for discussion of the toxicity problem. The Center has developed a test for determining relative toxicity under specified conditions. Beyond that, the Center has pulled together the parties of interest in seminars and other meetings to review current information and to find a solution. As a division of a Federal Agency, the Center has effectively served in the role of a neutral but knowledgeable leader in this effort.

The recent contributions of the Center to design of fire protection for nursing homes, advancement in automatic sprinkler protection, development of tests for material characteristics, prediction methodology for fire resistance of structural members, and other scientific and technical developments, are tangible evidence of the effectiveness and practicality of the bureau's work in the fire area.

This work will not likely be assumed by the private sector, as I mentioned previously, and, in most other developed countries, fire research is conducted by governmental agencies. This type of research should be continued by the Center for Fire Research. I make this recommendation as President of Underwriters Laboratories, a private laboratory conducting more fire testing, in all probability, than any other organization within the United States. Our work, like much of that in the private sector, is oriented to specific products and consists of practical but narrowly oriented efforts. We look to the Center for Fire Research for leadership in developing the scientific and theoretical information on which practical implementation of engineering knowledge can be based. It would be a terrible setback if this source were eliminated, not just for Underwriters Laboratories but for the fire community.

I understand that the Federal Government, just like our organization, must make difficult choices regarding use of its resources. In making this particular choice, it is my belief that the Center for Fire Research should receive a high priority because, as covered in this letter, it serves a unique and specialized need, not furnished by the private sector, and it has a track record of accomplishment.

Thank you for your consideration of my views.

Cordially,

Jack Bono

JACK BONO
President

JAB:AGA

APPENDIX iii

B.G. WOODHAM, JR., President
DON CASSIDY, SR., Vice President

SHELDON H. CADY, Executive Vice President, Treasurer
KENNETH D. MENTZER, Director, Materials & Standards

mima
Mineral Insulation Manufacturers Association

382 Springfield Avenue
Summit, NJ 07901-2782
(201) 277-1550

February 15, 1985

The Honorable Doug Walgren
Subcommittee on Science, Research
and Technology
2319 Rayburn House Office Building
Washington, DC 20515

Dear Representative Walgren:

The Department of Commerce has again proposed the complete phasing out of the Center for Building Technology (CBT) within the National Bureau of Standards. The members of the Mineral Insulation Manufacturers' Association, Inc., (MIMA), whose names are listed below, believe that elimination of this center must not occur and that every possible effort should be made to preserve and continue the CBT with adequate funding. We wish to submit the following for the record.

The Center for Building Technology is our country's only non-proprietary laboratory which can supply the type of research and development that cannot be obtained from private sources but which can stimulate private sector research as a result of its findings. The Center for Building Technology is the rallying point on insulation products, insulation systems, and thermal testing between industry, NBS, other government agencies, ASTM, ASHRAE and others. It is inconceivable that Congress would consider leaving the United States as the only developed country without a national building research laboratory. This would be an irreplaceable loss to the building community, the nation, and the international research community.

Of particular importance to our industry in recent years is the provision by the Center for Building Technology of measured calibrated transfer specimens for use in conjunction with the "representative thickness" provisions of the Federal Trade Commission Rule, "Labeling and Advertising of Home Insulation", 16 CFR 460.5. Test data was generated by the 1000 mm line-heat source guarded hot plate; documentaiton was obtained regarding the test appropriateness and the theory of heat flow in thick insulations. MIMA provided a Research Associate to assist in this development at a cost of $50,000.

This program could not have been accomplished by private industry within the prescribed time limits. One insulation manufacturer with extensive research facilities invested in excess of $600,000. in 1976-78 in research and development directed toward implementation of full thickness testing. They concluded that they were still not confident that full thickness testing was mature.

The FTC was urged by industry to defer its implementation of the full thickness testing section of its Rule until the NBS 1000 mm guarded hot plate and the related measured calibration transfer specimens were available. It was estimated that, in the fourteen months required to complete this development, manufacturers would be exposed to a rash of civic petitions for non-compliance with the test method than required by the FTC. This test method had already been determined by NBS CBT to be not feasible. Increased costs of industry for this immediate compliance, which would have had to be passed to the consumer, were estimated to be around $90 million for the fourteen month period.

Currently, the members of MIMA are discussing with the staff of the Center for Building Technology a proposed research program to develop a method for measuring installed loose-fill insulation R-value. There is a growing concern throughout the United States that home owners may not always be having the correct amounts of insulation installed in their homes. The present state-of-the-art in measurement of installed insulation R-values is unsatisfactory. A more sophisticated and accurate procedure is not only desirable, but necessary. The expertise and facilities of the Center for Building Technology, as well as its non-proprietary nature, are necessary to achieve the desired results in the interests of the nation's home owners and of the nation's need to conserve energy.

Other activities by the Center for Building Technology of importance to the mineral fiber insulation industry:

a). Thermal wall mass study: an independent evaluation to predict the effect of wall mass on energy use.

b). Development of thermal test methods for building and insulating materials that will determine their thermal properties as required for cost-effective materials selection and building envelope design. (The Calibrated Hot Box).

c). Development of techniques to assess the airtightness in houses.

d). Development of diagnostic procedures, measurement techniques, and interpretation methods for in-situ assessment of the thermal integrity of building envelopes.

e). MIMA was one of the instigators of the NVLAP program relating to insulating products. The Center for Building Technology's inspection of apparatus and standard testing procedures under the program is, again, an important non-proprietary contribution to the establishmnet of quality assurance for buildings.

f). The activities of the Building Physics Division in the interests of energy conservation are too numerous for specific mention. Their independent research, accomplished by no other organization, is of immeasurable help in providing industry with unique data.

g). The Center for Building Technology is the major non-proprietary source of technical information for the development of voluntary standards for the thermal performance of buildings by the American Society for Testing and Materials, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, and building code organizations.

NIMA appreciates the opportunity to submit its opinions to your committee. We urge that Congress restore appropriate funding to the Center for Building Technology. These elements within our nation's sole national building research laboratory must continue to work on R&D projects to provide the information needed by Federal Agencies interested in building and to provide technology that private industry alone cannot provide.

Thank you for considering our views.

Sincerely yours,

Sheldon H. Cady
Executive Vice President

SHC/tkl

TELEPHONE 313-532-2600
TELEX 810 2211451

aci

american concrete institute

BOX 19150
22400 WEST SEVEN MILE ROAD
DETROIT, MICHIGAN 48219

March 7, 1985

The Honorable Doug Walgren
Chairman, Subcommittee on Science,
Research and Technology
House of Representatives
2319 Rayburn House Office Building
Washington, D. C. 20515

Re: Reauthorization of the Center for Building Technology

Dear Congressman Walgren:

We understand that the proposed fiscal 1986 Federal budget once again eliminates funds for the Center for Building Technology (CBT) and its programs. The American Concrete Institute, through its Executive Committee, wrote you last year regarding the continuation of the Center and the Committee has agreed to resubmit our comments and to support the reauthorization of CBT.

In general, we stand behind the efforts being made by Congress and the Administration to bring the nations debt load under control by reducing the cost of Government. However, elimination of the Center and its activities would result in a greater cost to the nation than the savings realized. In the Committee's opinion, CBT provides research capabilities and perspectives which would be difficult to duplicate in the private sector.

For background, the American Concrete Institute is a nonprofit, technical society whose purpose is to further engineering and technical education and scientific research on concrete. The Center for Building Technology, through its technical activities, has been of great help to ACI in achieving these aims. We are a voluntary consensus standards-developing organization and publish standards concerned with concrete design and construction using procedures approved by the American National Standards Institute (ANSI). ACI is an individual membership society of almost 18,000 members and membership is open to anyone interested in the design, construction or use of concrete.

As an organization dedicated to the improvement of technology related to the use of concrete and to the development of voluntary

progress through knowledge

consensus standards, ACI relies greatly on the technical output of the Center for Building Technology. The test methods and technical data provided by this unit of the National Bureau of Standards are essential ingredients in advancing the nation's technology and improving its standards related to concrete. Without this input, the work of the American Concrete Institute would be impaired. Both industry and the consumer would suffer. The construction industry is very large (almost ten percent of Gross National Product), but by its very nature the construction community is very fragmented. It is unrealistic to expect that industry would fill the gap which would be created by the discontinuance of these National Bureau of Standards activities.

The National Bureau of Standards programs dealing with buildings are the only integrated programs in the nation able to deal with complex technical issues affecting the entire building industry. These programs make major contributions to reducing the burden of unnecessary and ineffective building regulations while maintaining essential levels of safety. The elimination of these programs would leave the United States as probably the only developed country in the world without a national building research laboratory.

We wish to be recorded as endorsing the reauthorization of the Center for Building Technology and its programs. In our opinion, the Center is engaged in important research and developmental projects that will result in the increased economy and safety of concrete structures, both when under construction and when occupied by the public.

Yours very truly,

George F. Leyh

George F. Leyh
Executive Vice President
(For the Executive Committee of the American Concrete Institute)

GFL/LP

cc: ACI Board of Direction

UNITED STATES GYPSUM COMPANY
700 North Highway 45/Libertyville, Illinois 60048
RESEARCH CENTER
AREA CODE 312
[illegible]

February 27, 1985

Congressman Doug Walgren
Chairman, Subcommittee on Science
Research and Technology
House of Representatives
2319 Rayburn House Office Building
Washington, DC 20515

Dear Congressman Walgren:

I have learned that the fiscal 1986 budget proposal sent to Congress by President Reagan does not include any money for the Center of Building Technology (CBT) in the Commerce Departments National Bureau of Standards. It seems incredible that this be repeated year after year. I can only hope that Congress will continue to support this vital activity by restoring the budget necessary to keep the programs of CBT active.

Both the economy and the welfare of the people of this country are so dependent upon the building industry but research in this field gets very little support. The industry is so fragmented that it needs a central organization to assure that proper standards are developed and that basic information is available for advancement, particularly in relation to international competition in new building systems.

I have asked CBT for some information to cite to you regarding its impact on the building industry and some of its major accomplishments. Perhaps you have seen these, but I would endorse them to your attention in an effort to restore the CBT budget.

Very truly yours,

Lawrence T. Eby, Ph.D.
Principal Associate, R&D

LTE/lm
Enclosures

February 15, 1985

THE IMPACT ON THE U.S. BUILDING COMMUNITY OF THE PROPOSED TERMINATION OF THE NBS CENTER FOR BUILDING TECHNOLOGY

The entire NBS program in Building Research would be eliminated. The program develops technologies to predict, measure, and test the performance of building materials, components, systems, and practices. The program includes substantial efforts in advanced computation and automation, structural engineering, earthquake hazards reduction, building physics, building materials, and building equipment. This is the only integrated building research program in the Nation able to deal with complex technical issues affecting the entire building industry. This giant, but disaggregated, industry amounts to almost 10 percent of the Gross National Product. Two-thirds of the Nation's wealth is invested in constructed facilities. This program is looked to by the private sector for technical bases for responsible and cost-effective decisions in the building process that cannot be obtained through proprietary research and development (DoC Inspector General Semi-Annual Report to Congress, April-September 1983).

- The U.S. would be the only developed country in the world without an integrated, interdisciplinary national building research laboratory. Unique and comprehensive laboratory facilities would be lost, for instance the tri-directional structural test laboratory, 12-million-pound testing machine, environmental chambers, guarded-hot-plate and calibrated hot-box, plumbing tower, anechoic and reverberation chambers. Federal agencies, such as GSA, FEMA, OSHA, and the White House, would lack an authoritative laboratory resource to deal with their building research needs.

- The U. S. would lose its only integrated, nonproprietary program aimed at removing technological market barriers of the construction industry, and reducing burdens of unnecessary or ineffective building regulations while maintaining essential levels of safety. Private sector R & D and innovation are stimulated by this program's authoritative, nonprescriptive performance measures for building materials, components, systems, and practices. This program is the major nonproprietary source of technical information for the development of voluntary standards for buildings by organizations such as the American Society for Testing and Materials, American Concrete Institute, American Society of Heating, Refrigerating and Air-Conditioning Engineers, American Society of Civil Engineers, and building code organizations.

- NBS would be unable to carry out its key assigned role in the National Earthquake Hazards Reduction Act for the technical support of the development of seismic design and construction provisions.

- The U.S. would lose the only Federal laboratory capable of investigating major building and construction failures, e.g., the walkway collapse in the Kansas City Hyatt Regency in 1981 and the East Chicago, Indiana highway ramp collapse in 1982.

- The U.S. would lose the quality assurance program for 580 public and private laboratories nationwide that are relied upon by owners, designers, builders, and State and local governments responsible for buildings and transportation facilities.

TOP ACCOMPLISHMENTS FOR CBT

1. Research results on occupancy, wind, and earthquake loads, prediction of structural resistance, and structural reliability are incorporated in the 1982 ANSI Standard "Minimum Design Loads for Buildings and Other Structures" and available for use in building codes. New provisions will increase structural reliability and reduce design costs.

2. Investigated and reported on the physical causes of major structural failures, such as the 1981 walkway collapse in Kansas City that killed 114, the 1982 overpass failure in East Chicago that killed 13 construction workers, and the 1978 cooling tower collapse at Willow Island that killed 51 construction workers, to assure that causes are publicly known and can be avoided in the future.

3. Provided technical support to the private sector Building Seismic Safety Council in the formulation of nationally applicable, comprehensive seismic design provisions suitable for use in voluntary standards and building codes, and in the development and conduct of a trial design program to provide the basis for recommendations of the provisions for adoption.

4. In cooperation with the National Conference of States on Building Codes and Standards and the State of Massachusetts, developed a more cost effective approach to regulation of building rehabilitation that has been adopted by Massachusetts and incorporated in rehabilitation guidelines of the Department of Housing and Urban Development, and formulated methods for condition assessment of existing buildings that are being processed as a national standard by the American Society of Civil Engineers.

5. At the request of the National Conference of States on Building Codes and Standards developed a technical approach for a nationally applicable energy conservation design standard for buildings that has been developed as a national standard by the American Society for Heating, Refrigerating and Air-Conditioning Engineers and provides the basis for the energy building code requirements of all 50 states.

6. Developed and verified, through laboratory and field studies, dynamic computer simulation techniques for predicting the performance of building enclosures, equipment and controls to make feasible designing to meet economic, functional, and energy conservation requirements in new and existing buildings. These techniques have been made publically available, incorporated in national standards, and used as technical bases and benchmarks for proprietary computer programs for building designs.

7. In response to legislation: formulated performance criteria for solar heating, cooling, and hot water systems for residential and commercial buildings that provide technical bases for the design, testing, installation, and operating practices of the $800 million per year industry that has developed in the past decade; formulated test methods, now incorporated in national standards, for assessing the durability of materials in solar

systems and the thermal efficiency of solar components to provide effective communications between suppliers and users in the marketplace.

8. Developed a one-meter line source guarded hot plate to permit direct measurement of thermal insulation performance at thicknesses up to 15 inches (the earlier standard was 1 inch) and provided calibrated transfer specimens to manufacturers to allow them to meet labeling requirements without excessive uses of material.

9. In cooperation with the National Roofing Contractors Association developed the first performance criteria and test methods for reliable low-slope roofing systems and disseminated them in biannual National Roofing Conferences.

10. Developed performance criteria and test methods for protection of reinforcing bars in concrete from salt-induced corrosion. These have substantially increased bridge deck service lives through incorporation in national standards, development of a new industry producing coated reinforcing bars, and their use in most bridge decks in areas subjected to freezing weather.

11. Formulated a systematic method for prediction of the service lives of building materials that assesses the mechanisms of degradation in the service environment and develop accelerated testing procedures that are representative of performance in the service environment. The method has been adopted for U.S. practice in a standard of the American Society for Testing and Materials and is under consideration for international standardization. These results permit reliable and equitable selection among innovative and traditional building materials in domestic and international commerce.

12. At the request of the American Society for Testing and Materials and the American Association of State Highway and Transportation Officials, inspections are provided of test equipment, procedures, and results for 580 public and private construction materials laboratories nationwide to strengthen quality assurance for building and transportation facilities.

1/23/85

MAJOR CBT ACCOMPLISHMENTS IN FY 1984

1. Conducted field tests at Japanese sites that had undergone soil liquefaction in recent earthquakes to compare directly the results of U.S. and Japanese standard penetration tests for soils. The results permit more reliable comparisons of Japanese and U.S. data for assessing the liquefaction potential of sites for construction.

2. Initiated use of a unique structural loading facility capable of simulating earthquake force and displacement histories with computer control of six degrees of freedom. Research results have been reported on unreinforced masonry walls loaded cyclically to failure in shear. These results provide critically needed data for assessing the seismic safety of unreinforced masonry structures and baseline data for studies of the effects of wall reinforcement on the strength and energy absorption capacities of masonry.

3. The Recommended Provisions for the Development of Seismic Regulations for New Buildings produced by the private sector Building Seismic Safety Council (BSSC) incorporate results of NBS research and received vital technical support from NBS in a decade-long development process. In cooperation with the 57 private and public organizations represented on BSSC, NBS managed the original formulation of tentative provisions from bases in research and practical experience, analyzed the tentative seismic provisions for technical and logical consistency and completeness, planned a trial design program involving 46 buildings in 9 cities to evaluate the provisions, and provided technical assistance to the BSSC committees in overseeing the trial design program and in revising the provisions in light of trial design results.

4. Commissioned a Calibrated Hot Box apparatus that provides precise measurements of heat and moisture transfer in full scale building wall sections (10 by 14 feet) that may include doors and windows. The apparatus simulates temperatures, humidity and air movements for a wide range of climatic conditions. Steady-state heat transfer coefficients for test walls now can be determined within one percent. These results provide bases for calibrations and test methods to be used in commercial laboratories.

5. Developed a system for the direct measurement of acoustical intensity in real, semi-reverberant spaces with the capability of distinguishing between signals of interest and background sounds. The system is based on the relationship between acoustical intensity and the imaginary part of the cross-spectral density of the outputs of two closely-spaced microphones. The system was made feasible by recent advances in computers and signal processing techniques. It provides an accuracy of 0.5 dB in the 100 to 700 Hz range in semi-reverberant conditions and in the 100 to 4000 Hz range in anechoic condition.

6. Developed a test method for air leakage and ventilation efficiency in large buildings required for control of energy use and indoor air quality. The method is based on tracer gas technologies and dynamic modeling of

interzone air flows. It is verified by field and analytical studies of air leakage and ventilation in eight Federal buildings in a variety of regions and climatic conditions. The test method is under consideration for a standard of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

7. Developed and verified a dynamic building heating, ventilating and air-conditioning system and controls simulation program. A hierarchical, modular approach accounts for wide-ranging dynamic response characteristics and provides computational stability and efficiency. It will provide the basis for a new generation of computer programs for building energy analysis that are capable of simulating performance of equipment and controls.

8. Developed field calibration methods for humidity, flow and temperature sensors for computer-based energy management and control systems (EMCS). The American Society of Heating, Refrigerating and Air-Conditioning Engineers is using these methods as bases for a new standard. EMCS are sold by over 100 companies and used in most new commercial and institutional buildings. These systems cannot function adequately without accurate calibration of sensors.

9. Developed a novel experimental apparatus for measuring the boiling heat transfer coefficients of mixed, non-azeotropic refrigerants. These results are required to predict the performance of improved heat pumps and air-conditioners with mixed refrigerants.

10. Organized the architecture, engineering and construction working group for the development of a voluntary national standard for the automatic exchange of geometric and nongeometric data describing building plans. These interface standards are needed to allow integrated computer aided design and construction since a new team of owners, designers, manufacturers, and contractors generally is involved in each building project and team members will use diverse, proprietary computer hardware and software.

11. Developed a technique for laboratory evaluation of the service lives of protective coatings for steel. The technique employs infrared thermography and computer image analysis of painted steel panels exposed to accelerated weathering in the laboratory to produce a probabilistic analysis giving expected service life as a function of exposure conditions. The technique, which will be automated, promises to give more reliable and more rapid evaluations of new coating formulations than has previously been possible. The Steel Structures Painting Council is working with NBS in the application of this technique.

12. New data were used to correct errors in the long-accepted lime - alumina - sulfate - water phase diagram for portland cements. Knowledge of this phase diagram is essential to understanding the reactions of portland cements with water. In particular, it is needed for the development of the mathematical models which will make concrete a more predictable material. Concrete is the most widely-used, man-made material of construction; it is essential to the construction and maintenance of the Nation's infrastructure.

ROSS & BARUZZINI, INC.
ENGINEERS-ARCHITECTS

AREA CODE 314
725-2242

7912 BONHOMME AVENUE
ST. LOUIS, MISSOURI 63105
Reference No. 305X3-17

February 22, 1985

The Honorable Douglas Walgren
Chairman, Subcommittee on Science Research and Technology
Committee on Science and Technology
2441 Rayburn House Office Building
Washington, DC 20515

Re: National Bureau of Standards Center for Building Technology

Dear Congressman Walgren:

I have learned recently of a proposal contained in the President's 1986 Budget Request to eliminate the Center for Building Technology at the National Bureau of Standards for reasons that the research conducted by this group is more properly the role of the private sector and state and local governments.

While there are, as in any complex endeavor, undoubtedly some programs being conducted within the Center for Building Technology that could be reduced, the overall work performed by this group fulfills a critical need for the building industry in our country. This is an industry contributing the most to our Gross National Product, and one recognized as requiring a great deal of research to improve its effectiveness.

I can speak first-hand as an individual engaged in the professional design of buildings and building processes for over 30 years, the greater portion of which has been as a principal in an engineering and architectural design firm. As a participant in private sector research, I am sure that our company, myself included, has contributed greatly on a voluntary basis. (At the present time, I am serving as a voting member of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) committee to revise Building Energy Standard 90-35. This effort has involved more than 350 man-hours during the past year of my time alone. Additional effort for programs conducted by the Illuminating Engineering Society (IES) and the Institute of Electrical and Electronic Engineers (IEEE) involves a substantial amount of time also.)

I feel, therefore, that I can speak both as a practitioner within the industry and as a volunteer attempting to develop this information for the industry from the private sector. Coupled with this background, it has been my good fortune to work with the staff of the Center for Building Technology over many of the past years. I can assure you of the absolute need for the information developed at the Center and its pertinence to our day-to-day activities in the construction industry. This critical need is satisfied by a combination of two factors: First and foremost, a dedicated staff of professionals at the Center and, secondly, facilities second to none with which measurements can be conducted, and results disseminated on a non-proprietary basis.

Just one example is an environmental test chamber for simulating and measuring large portions of buildings in order to determine the subtle but complex relationships taking place in energy transfer through a building. This provides hard facts so that designers can more closely predict the actual performance of their designs. In a joint project in which our office is being funded by the Electric Power Research Institute, while the Center for Building Technology is being funded by the Department of Energy, this close collaboration between the needs of the federal government and those of the electric power industry, all for the benefit of building users, will combine to provide answers to problems greatly disturbing the design profession until now.

It may be of interest to note that once before, in the past, in a budget-cutting program at the Center, a large environmental test chamber was destroyed. Recently, because of demonstrable need, it was reconstructed. Let's not repeat the cycle yet another time!

This correspondence is probably already too long for the purposes intended: to request that you carefully evaluate the important results being obtained from this group; and to convince you that, should the Center for Building Technology be closed, the personnel transferred to other activities, and the research facility lost, the construction industry will have lost one of its most vital means for increased effectiveness.

I would be pleased to respond to any direct questions that may be raised by my concern.

Respectfully submitted,

Donald K. Ross

Donald K. Ross, Sc.D.

DKR/dn

W.S. FLEMING & ASSOCIATES, INC

5802 Court Street Road
Syracuse, New York 13206
(315) 437-1780

February 20, 1985

The Hon. Doug Walgren
Chairman, Subcommittee on Science,
  Research, and Technology
Committee on Science and Technology
2441 Rayburn House Office Building
Washington, D.C. 20515

Dear Sir:

It has come to my attention that the Center for Building Technology of the National Bureau of Standards will be eliminated in the 1986 budget proposal sent to Congress by President Reagan.

As a person who has had experience with large corporations (Owens Corning Fiberglas, Carrier, Rheem) and small businesses providing professional services (W.S. Fleming and Associates, Inc. (WSFA)) to the construction industry, it is my firm belief that eliminating the Center for Building Technology and the Fire Research Program would be detrimental to our professions, the industry, and the economic structure of this country.

I am a disabled Vietnam Veteran who was able to implement a profession (other than flying attack aircraft in the South China Sea) as a result of technology transfer between the Center for Building Technology (CBT) and the Constitution Industry. The advanced technologies that were implemented would not have been available within large corporations or my relatively small engineering business without the scientific work provided by the CBT.

The success of my current business and the growth opportunity it provided myself and others were direct results of an organization within the National Bureau of Standards (NBS) that the President's proposal would eliminate - The Center for Building Technology.

For example:

- The current ASHRAE Energy Standard, of which I was the chairman of the Manual of Acceptable Practice, was initiated and drafted by CBT.
- Current steady-state heat transfer coefficients for energy effective residential, commercial, and institutional buildings designed by my firm are provided by CBT.
- Current indoor air quality work that is being completed by my firm in New York State utilized air leakage, ventilation efficiency, tracer gas, and dynamic modeling technologies that were obtained from NBS scientific work. The results of our work in New York

CONSULTING ENGINEERS
Albany, New York   Syracuse, New York   Washington, D C

State would not be complete and action of the state so positive, for the health and well being of its citizens, if WSFA did not have access to technologies developed by the CBT.

- Our current building energy simulation program (ENSIM) would not be complete, nor available to others within the construction industry had not we had access to the NBS computer programs from 1975 to date.

- My firm would not have been able to provide an advance technology EMCS System Design and Specification to Marriott Corporation for optimum control of the Marriott Times Square and Marriott Orlando projects without technology transfer from the NBS CBT.

- As chairman of ASHRAE TC6.7 Solar Energy Utilization, I can say (as a person), the performance and operating information provided by NBS was vital to the development of that subsector of the construction industry. Had it not been for efforts provided to the construction industry by NBS; R&D would not have been possible because of cost restrictions of small manufacturers within the industry. The 800 million dollar market that employs thousands would be non-existant.

In summary, I have spent my life serving our country as a professional military person and engineer. As the military requires institutions to provide scientific research, development, and technology transfer; so do professional persons and small or large business within the construction community. This country's largest asset is our advancing technical knowledge. If we do not continue to acquire technology that can be provided by government institutions, the economic structure of the construction industry will fail; just as advanced technologies to our military would become non-existant. To continue this country's technological development and growth, we must continue to allow the CBT to investigate, because without investigation, there is not discovery - without technical discoveries, our growth and our next generations economic future may be jeopardized.

Sincerely,

WS Fleming

William S. Fleming
President

WSF/ph

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.

ASHRAE 1791 Tullie Circle, N.E. Atlanta, GA 30329 Telephone 404 [illegible] 8400

Dr. Jack B. Chaddock
Presidential Member

Reply to: Mechanical Engineering
[illegible]
[illegible]
Durham, NC 27706
[illegible]

February 15, 1985

Representative Doug Walgren, Chairman
Science, Research and Technology Subcommittee
U.S. House of Representatives
Washington, D.C. 20515

re: Center for Building Technology, National Bureau of Standards

Dear Mr. Chairman:

In 1981-82 it was my privilege to serve as President of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). This engineering society is comprised of some 45,000 members including about 5000 from overseas countries. ASHRAE is viewed as the world leader in advancing technological knowledge in its areas of engineering specialization. Key among its activities are:

1. The publication of Handbooks used in the education of engineering students, the design of building mechanical systems and refrigeration systems, and the advancement of all elements of engineering practice in air conditioning and refrigeration.
2. The writing of voluntary consensus standards to serve and protect the public by assuring quality of product.
3. The holding of meetings, conferences, symposia, etc. at which new knowledge is presented and critiqued in a peer judgement atmosphere.

In all of these ASHRAE activities I have seen a continuing important involvement of staff and publications from the NBS Center for Building Technology. There is no other organization in this country which has brought together a quality professional and scientific staff of such size and diversity of knowledge to be able to address building technology as a whole. The demise of this Center would leave a void of investigative technique that could not be filled by industry, educational institutions, or voluntary society activity.

During the period from 1974 to 1982 I served as the United States representative to the International Building Commission on Research and Documentation's (headquarters in Rotterdam, the Netherlands) working commission on building energy conservation. Over those years we held annual workshop meetings and three international symposiums. I learned much about the major role of buildings in the economy and conduct of world affairs. Nearly every country that participated in those workshops and symposia had a government supported central research activity on building construction and building performance. The directors and assistant directors of these centralized building research laboratories were leading authorities in some aspect of building architecture, construction, mechanical design, lighting or other building specialty.

In the period 1976-1982 I was a member of the National Academy of Sciences Review Panel for the Center for Building Technology. The Panel held annual reviews at the National Bureau of Standards location in Gaithersburg, Maryland, which gave me additional opportunity to view first-hand the contributions made to the building community and the nation by the CBT staff. I was continually impressed by the quantity and quality of the research work and of its timeliness in helping this nation adjust to continually changing demands for building technology.

I would urge you and other members of the subcommittee on Science, Research and Technology to carefully examine the record of accomplishment of the Center for Building Technology. I firmly believe that if you do, you can be left with no other conclusion than that its services to this nation and the practitioners of building technology is of such value that it must be retained.

Sincerely,

Jack B Chaddock

Jack B. Chaddock

JBC:lh

ccs: The Honorable I. T. Tim Valentine, Jr.
The Honorable William W. Cobey, Jr.

CBT
#40

AMERICAN ASSOCIATION OF STATE HIGHWAY
AND TRANSPORTATION OFFICIALS

[illegible]

FRANCIS B. FRANCOIS
Executive Director

March 11, 1985

The Honorable Doug Walgren, Chairman
House Subcommittee on Science, Technology
and Research
2319 Rayburn House Office Building
Washington, D.C. 20515

Dear Congressman Walgren:

I understand your Subcommittee has held a hearing on the question of authorization for the National Bureau of Standards. I further understand that the Administration's FY 1986 budget request for the NBS calls for, among other things, the elimination of the Center for Building Technology. It is about this last matter that I am writing to you.

The American Association of State Highway and Transportation Officials (AASHTO) is the national association of state departments of highways and transportation. Among their duties dealing with all transportation modes, the state agencies comprising AASHTO are responsible for planning, designing, constructing and operating the nation's principal system of highways. An important part of that responsibility is an adequate program of quality assurance with respect to the materials used in the construction and maintenance of our highways. This quality assurance role is accomplished through a material division in each of the departments, each of which operates one or more materials laboratories to conduct the necessary testing and evaluation.

Recognizing the importance of consistency in such materials testing across the country, the AASHTO Materials Reference Laboratory (AMRL) was established in 1965 under an agreement with the National Bureau of Standards. The purpose of the AMRL was and is to provide a quality assurance program for the state materials laboratories themselves. This has been accomplished through two programs, both of which now are done AMRL under the overall auspices of the National Bureau of Standards and its Center for Building Technology. These are:

- o A sample reference program wherein test results from participating laboratories on soil and asphalt samples prepared from a central source are statistically evaluated for consistency, and
- o A physical inspection of the state laboratories and their equipment, conducted on a rotation cycle of approximately 30-months duration.

EXECUTIVE OFFICE: 444 N. Capitol Street, N.W., Suite 225 Washington D.C. 20001 Telephone (202) 624-5800

While it is managed by the NBS, the costs of the AMRL program have been borne principally by the state departments involved, with assistance from the Federal Highway Administration, on billings made to AASHTO by the NBS. Other financial resources have been received through fees paid by outside laboratories, who have chosen to participate. None of the needed resources have been provided from funds appropriated for NBS, since the NBS bills us for all the costs involved.

With the perspective of 18 years hindsight, the AMRL program has indeed been a success. The state highway and transportation departments have been afforded a sound, well managed mechanism to assure the quality and consistency of their materials laboratories and attendant procedures. While there has been no financial benefit to the states resulting from the connection with NBS, because of their billings to us, we feel their involvement has been pivotal to our success for several reasons. Among these are the prestige and clear unassailability attendant to the involvement of, and objective management by, the nation's principal scientific measurement agency, its NBS. Another is the distinct absence of a federal regulatory role; the service provided through the NBS merely provides a basis on which the states may regulate themselves. We fear these important factors could be lost if the proposal for elimination of the Center for Building Technology is approved. That there would be some other unit within NBS to which AMRL could be attached seems problematical at best, and very likely impractical.

There is another similar program also now in jeopardy by such an elimination. This is the Cement and Concrete Reference Laboratory (CCRL), sponsored through NBS in virtually an identical fashion by the American Society for Testing Materials (ASTM). Our state highway and transportation departments avail themselves of this service coincidentally with that afforded by AMRL, and compensate the CCRL program through fee payments. These two programs are closely related in that they each serve many of the same clients and are now managed by the same NBS employee. Thus, many of the comments on AMRL, above, are equally applicable to CCRL.

I would be pleased to provide any additional information you may wish. Simply call me or my Deputy Director, Mr. David Hensing, at 624-5800.

Very truly yours,

Francis B. Francois
Executive Director

encl.

FBF:DJH:tcd

cc: The Honorable Don Fuqua, Chairman
House Subcommittee on Science, Technology
and Research
2331 Rayburn House Office Building

Carnegie-Mellon University

Department of Civil Engineering
Schenley Park
Pittsburgh, Pennsylvania 15213
(412) 578-2944

Steven J. Fenves
University Professor

March 11, 1985

Congressman Doug Walgren
Chairman, Subcommittee on Science,
Research and Technology
House of Representatives
2319 Rayburn House Office Building
Washington, DC 20515

Dear Doug:

For the third consecutive year, I am contacting your Committee concerning the NBS authorization, specifically, the proposed elimination of the Centers for Building Technology and Fire Research.

I fully support the maximum utilization of the private sector and state and local governments in research leading to improved safety and economy in the built environment. I also fully support the Administration and Congress in the difficult task of reducing the federal budget deficit. Nevertheless, I strongly believe that the $8.2 million "saving" resulting from the elimination would be ephemeral in comparison to the societal costs were these functions abolished.

The Centers for Building Technology and Fire Research provide a unique function as a neutral meeting ground, where technical concerns common to users, suppliers and regulators can be addressed in an impartial fashion. Compared to, say, the agricultural and pharmaceutical industries, the federal investment in research for the construction industry is minicule. Nevertheless, the two Centers provide great leverage to the Federal Government, one of the major clients of the industry, through their basic technical research aimed at improved construction techniques and improved standards in the industry. Similarly, on the international scene, the two Centers provide a US voice and representation comparable to that of countries, such as the United Kingdom, France and Japan, which spend orders of magnitude more on construction research.

I urge your Committee not only to restore the funds, but to put the two Centers on a permanent footing. The morale and productivity of the two Centers has suffered greatly from these annual battles for survival.

I am, of course, ready to assist you and your Committee in any way that you may wish to use me.

Sincerely,

Steve J Fenves

SJF/bl

Steven J. Fenves

NATIONAL
ROOFING
CONTRACTORS
ASSOCIATION

8600 Bryn Mawr Avenue
Chicago, Illinois 60631-3502
(312) 693-0700

February 26, 1985

The Honorable Doug Walgren
Chairman, Subcommittee on Science
Research and Technology
Committee on Science Research
and Technology
House of Representatives
Washington, D. C. 20515

Dear Honorable Congressman Walgren:

We have been informed that the President's budget submitted to Congress contains no funding for the Center of Building Technology at the National Bureau of Standards. We are dismayed and concerned. We urge your committee to restore funds for this vital activity and to provide funding for continuing and ongoing programming in this critical area.

The National Roofing Contractors Association has maintained a cooperative working relationship with the National Bureau of Standards and specifically with the Center of Building Technology for many years. The work that has been done at NBS relative to roofing technology and roofing performance has been outstanding and has been an extremely valuable addition to the information base of the commercial, industrial, and residential roofing community. We feel so strongly about the value of this ongoing programming in building technology that, even in these depressed times, our association is exploring to fund a research associate at the National Bureau of Standards. It would be an extreme setback to the roofing industry to lose the type and quality of programming that has been conducted over the years at NBS.

If you are interested in more detail, I will be happy to enumerate various programs at NBS and explain how the program and the program information has been directly and practically useful and helpful to the roofing industry. I am not aware of your personal response to this lack of funding, but on behalf of our association, I want to urge your critical examination of the important work that has been done and that can be done to assist the construction community in keeping abreast of technology and the concerns of building technology as they relate to performance, and to health and safety matters.

Yours very truly,

Fred Good
Executive Vice President

FG/sh
cc: Richard N Wright
Director, Center for Building Research
National Bureau of Standards

APPENDIX IV

International Union of
Bricklayers & Allied Craftsmen
815 Fifteenth Street, N.W., Washington, D.C. 20005 • Phone 202/783-3788

John T. Joyce
President

22 February 1985

The Honorable Doug Walgren
Chairman, Subcommittee on Science,
  Research & Technology
U.S. House of Representatives
2319 Rayburn House Office Building
Washington, D.C. 20515

Dear Congressman Walgren:

I am writing to ask you to use your best efforts to restore to the budget of the National Bureau of Standards funds for the Center for Building Technology and the Center for Fire Research.

Your Subcommittee will begin hearings on 26 February on the NBS budget of $120,000,000. Cut from this proposed budget are all funds for CBT and CFR. Earlier NBS budget proposals had included $3.1 million for CBT and $5.1 million for CFR.

The Commerce Department's proposed budget for the National Bureau of Standards would, if passed, bring to a total stop all building and fire research at NBS. Such a result would be disastrous to the interests of the general public and of the building industry whose output accounts for almost 10 percent of the country's gross national output.

The building industry, despite its size, is constituted in such a manner that private firms spend much less on research and development than their business counterparts in other industries. The reason is not a lack of interest, but, instead, is the simple result of the fact that most business organizations in the building industry are small and lack resources to undertake research. As a result, other organizations, including our own union, must try to make up some of the industry's r&d deficit, but those efforts are inadequate, also.

If the outstanding work in building research that has been done over the years by the Center for Building Technology is halted, the building industry will be deprived of its best ongoing research program. The result will be a loss of potential for technological advancement which our industry badly needs to be more efficient and compete effectively against foreign companies.

The loss to the general public would also be great. Programs of CBT and CFR have provided an objective means of measuring and testing building technology. They have undoubtedly protected citizens against faulty and shoddy materials and systems, but they have also spurred development of new technology that has helped advance public safety.

I urge you to work to keep CBT and CFR in the National Bureau of Standards Budget. Their requested funds would be well spent. To eliminate those funds would be penny wise and pound foolish.

Sincerely yours,

John T. Joyce
President

JTJ/plr

ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

1791 Tullie Circle NE • Atlanta Georgia 30329 ☎ (404) 636 8400 • Tlx 705343 ASHRAE

Robert O. McDonald
President

Reply to:
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March 5, 1985

Honorable Doug Walgren
Chairman of the Science, Research
and Technology Subcommittee
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) is a technical society of approximately 50,000 individual members, among them - consulting engineers, mechanical contractors, architects and employees of manufacturers, educational institutions, research organizations or government.

It is our understanding that the Center for Building Technology and Center for Fire Research at the National Bureau of Standards are being considered for phase-out in the coming year. ASHRAE would like to take this opportunity to comment on the potential effect of such an action on the private sector.

ASHRAE believes that the termination of the activities of both these centers at the National Bureau of Standards will leave a real and definite void in the Nation's research and development capability which will not be replaced by the private sector in the foreseeable future.

Research and development work initiated at the Bureau is continued and transferred to the public arena by the private sector. The two centers under discussion have produced research which finds its way promptly into the private sector for the benefit of the general public, business, industry and all levels of government.

ASHRAE develops voluntary consensus standards within its area of interest, which includes the building industry. Its most important and most known standard, ASHRAE/IES Standard 90, "Energy Conservation in New Building Design" was initially published in 1975 based on work done at the Center for Building Technology in response to the 1973 energy crisis. Standard 90, in either its 1975 edition or its 1980 edition, has been adopted

An International Organization

in whole or in part by 48 states as part of their state and/or local building energy conservation codes. The development work done by the Bureau's Center for Building Technology illustrates the overall approach needed to conserve energy in buildings when heating and cooling equipment, lighting, building services and the exterior envelope design and materials must be considered together. No single industry or industry group has the required expertise for this fully integrated approach to energy conservation. The original integrated energy conservation work of the CBT and ASHRAE/IES's consensus standard development is an excellent example of government agency- private sector cooperation for the public benefit.

ASHRAE has approximately 60 standards, all developed by consensus procedures. These standards cover subjects like ventilation for acceptable indoor air quality and thermal comfort in addition to energy conservation in buildings, but most ASHRAE standards are related to "Methods of Test" of HVAC&R equipment. More than one-third of the ASHRAE standards are based in whole or in part on information developed at the Bureau, further evidence of government agency-private sector cooperation.

Even though ASHRAE has the largest self-funded research program of any technical or professional society, with expenditures of approximately $1 million per year, the Society does not have the resources to fund all the research needed to suppport the development of all the needed standards. The Bureau significantly helps fill this need.

The NBS Center for Fire Research serves a need in fire prevention and control research that certainly is not and will not be duplicated elsewhere. The staff members have unique abilities in their aggregate that are unlikely to be assembled elsewhere and the nation will have lost a very valuable resource. ASHRAE and the Center combined in producing and marketing a manual for smoke control, "Design of Smoke Control Systems for Buildings," that has achieved considerable acceptance, further evidence of the cooperation that we would like to continue.

In summary, we believe that the Center for Building Technology and the Center for Fire Research complement the work of the private sector in the areas mentioned above and careful consideration should be given to these functions now and in the future.

Sincerely,

R.O. McDonald

Robert O. McDonald

ROM/tes

cc: Frank M. Coda
Preston E. McNall

William P. Chapman
8260 N. Gray Log Lane
Milwaukee, WI 53217

FEB 21 1985

Hon Douglas Walgren
Chairman, Sub-Com
Science, Research and Technology

February 15, 1985

cc J. Sensenbrenner

Dear Sir:

As a former president of the American Society of Heating Refrigerating and Air-conditioning Engineers (ASHRAE), and as a member of the National Research Council's Assessment Panel for the NBS Center for Building Technology, I have watched closely for Congressional investigations. In fact, I have written to House and Senate committees on previous occasions when there have been suggestions for curtailment or overly deep cuts. Certainly in the last five years, the NBS has curtailed several of the CBT programs, reduced staff, and cut operating budgets. Today the CBT is threatened with falling below the critical mass of effective size. The choice now lies between closing the CBT or maintaining it at its current scope.

My professional experience, of more than 38 years, and my personal assessment, as an NRC panelist, leads me to advise you to maintain the Center. Before retirement, I was VP-Technology for Johnson Controls (a $1.4 billion per year corp.) so I can say with authority that private industry cannot do the work being done by the CBT. Their work is too fundamental for most industrial research, but also it requires an industrial cooperation that is impossible for industry to organize. The CBT, on the other hand, can work with professional organizations like ASHRAE and NFPA and get the necessary coordination.

The staff at both the CBT and the Center for Fire Research are of the highest level of professional competence. They are respected by their industrial peers, they contribute to the literature of the professional societies, and they serve on the technical committees of those societies. Through years of careful, insightful planning the CBT has created a treasure of engineering and scientific work. It could not have been done by industry, and it will not be continued if the CBT is discontinued. Further its work can not be incorporated into other departments of the NBS, that concept has been studied and abandoned. Believe me, sir, as a frugal and conservative business man, I salute and support the President in his efforts to reduce government efforts where business efforts will do as well. But this is not such a case. I urge you to get copies of the NRC assessment reports. Study them and learn why the private sector supports the continuation of the Center for Building Tecnology and the Center for Fire Research.

Sincerely,

William P. Chapman
William P. Chapman

NINETY-NINTH CONGRESS
Congress of the United States
House of Representatives
COMMITTEE ON GOVERNMENT OPERATIONS
2157 Rayburn House Office Building
Washington, D.C. 20515

February 26, 1985

The Honorable Don Fuqua
Chairman
Committee on Science and Technology
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

Once again, the Institute for Computer Sciences and Technology (ICST) is under threat of deep budget cuts. If these proposed funding reductions are not reversed, the Federal Information Processing Standards Program would be terminated.

In my view, these proposed cuts ignore the significant benefits that have been achieved by this program. When P.L. 89-306 (Brooks Act) was enacted in 1965, there was no program to develop computer and communications standards for the Federal Government. Since that time, ICST has done a commendable job in developing standards that have benefitted both the government and the private sector.

More than three years ago, Joe Wright, Deputy Director of the Office of Management and Budget, testified before the Legislation and National Security Subcommittee that the issuance of 54 Federal Information Processing Standards by ICST was saving the government about $132 million annually. More recent estimates show savings of close to $700 million over a five-year period.

In light of the huge budget deficits that this nation is facing, it is clearly not in our best interests to cut a program that is saving the government each year more than $13 for every dollar spent. I want to take this opportunity to urge you to restore the funding for ICST at a level that would not only maintain their present activities, but would increase them.

With best wishes, I am

Sincerely,

Jack Brooks
JACK BROOKS
Chairman

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SKT

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COMMITTEE ON SCIENCE COMMITTEE ON SCIENCE
AND TECHNOLOGY AND TECHNOLOGY

NRMCA
NATIONAL
READY MIXED
CONCRETE
ASSOCIATION

900 Spring Street, Silver Spring, Maryland 20910
Telephone: (301) 587-1400

February 27, 1985

Congressman Don Fugua
Member, Subcommittee on Science,
Research and Technology
House of Representatives
2269 Rayburn House Office Building
Washington, D. C. 20515

Dear Congressman Fugua:

I am writing you regarding the proposed elimination of funding for FY '86 for the Center for Building Technology (CBT) and the Center for Fire Research (CFR) at the National Bureau of Standards. I understand the proposed budget will be before the Subcommittee on Science, Research and Technology (House) next month. The National Ready Mixed Concrete Association, a Trade Association representing 1000 companies who produce over 60 percent of the concrete used in construction strongly supports reauthorization of the CBT and CFR. Through a broad spectrum of activities, these sections of the National Engineering Laboratory provide basic research and participate in standards development and testing activities of great benefit to both the Federal government itself, the construction industry and the general public.

The Federal government builds and owns a significant portion of the building structures and construction in the U.S. and has a responsibility to contribute to the process which sets standards for all aspects of the building process. These Centers of the National Engineering Laboratory participate and contribute in important ways to the voluntary consensus standards writing activities of the American Society for Testing and Materials, the American Concrete Institute, the American Society for Heating, Refrigerating and Air-Conditioning Engineers, the American Society for Civil Engineers and the American National Standards Institute. The CBT and CFR have both worked to help state and local government establish building codes and regulations.

The Center for Building Technology has held a central position in drafting seismic regulations for buildings and organized an extensive design analysis of some 46 buildings in nine cities to verify the adequacy of these seismic regulations. They have been very active in solving the complex calculations that are required to predict the effect of dynamic thermal changes on energy required to heat and cool buildings.

There is a continuing need for an independent agency such as the CBT to investigate large and important structural failures such as those which occurred in the Willow Island cooling tower, the East Chicago overpass and the Kansas City Hyatt Hotel walkway.

They have done important research on the durability of roofing and leaks in flat roofs, a problem which has reached almost epidemic proportions in recent years.

We, therefore, urge you to retain adequate funding for the Center for Building Technology and the Center for Fire Research for fiscal year 1986 and allow these unique organizations to continue their invaluable research efforts. We appreciate the consideration of our views in your decision.

Sincerely,

Richard D. Gaynor

Richard D. Gaynor, PE
Executive Vice President
Research and Engineering

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
Cornell University
HOLLISTER HALL, ITHACA, N.Y. 14853

March 12, 1985

The Honorable Doug Walgren
House Science and Technology Committee
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Walgren:

For the second year in a row I am writing to express my concern regarding the proposed elimination of the Centers for Building Technology and Fire Research of the National Bureau of Standards.

On the technical side I have nothing to add to my letter of March 7, 1984 (copy enclosed). The Centers are still good and I am sure their recent accomplishments are being reported in adequate detail in testimony before your committee.

On the human side there is something to say. Twice before the Administration moved to eliminate these groups. Both times the engineering community demonstrated its regard for their continuation. This third attempt starts to smack of harassment. It must be demoralizing to the people in the Centers. I hope the Administration's proposal is defeated and that it will accept the proposition that, even in this game, three strikes should be out.

Thank you for your consideration.

Sincerely yours,

W. McGuire
Professor of
Structural Engineering

WM/pjk

Enclosure

Cornell is an equal opportunity, affirmative action educator

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
Cornell University
HOLLISTER HALL, ITHACA, N.Y. 14853

March 7, 1984

The Honorable Doug Walgren
House Science and Technology Committee
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Walgren:

I would like to call your attention to the enclosed editorial from the February 9 Engineering News-Record. I share ENR's concern for the proposed elimination of the Centers for Building Technology and Fire Research of the National Bureau of Standards.

I know these people. I spent part of a sabbatic at the CBT in 1972. In addition, I have been a consultant to the Center on its investigations of the Lake Placid Olympic Ice Rink, the Hyatt Regency failure, and the East Chicago ramp collapse.

The core of the CBT consists of a small group of highly educated, imaginative and dedicated structural engineers. Their applied research is well respected. They provide the closest thing the country has to a coordinating group for the development of structural codes and specifications. Perhaps most important, in the past ten years they have developed an excellent reputation for the thorough, impartial investigation of structural problems. For various reasons -- none good -- there has been a disturbing increase in such problems in recent years. The country needs the type of scrutiny these gentlemen give to our failures. Industry won't do it.

As the ENR editorial says, "these research groups perform a vital function at a small cost". I hope you agree and that you will oppose their elimination.

Thank you for your consideration.

Sincerely yours,

W. McGuire
Professor of
Structural Engineering

WM/pjk

Enclosure

Cornell is an equal opportunity, affirmative-action educator

PORTLAND CEMENT ASSOCIATION
5420 Old Orchard Road, Skokie, Illinois 60077-4321 · Area Code 312/966-6200

March 15, 1985

The Honorable Don Fuqua
Chairman, Committee on Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

The Portland Cement Association is the research, promotional and public affairs arm of the cement industry, representing approximately 65% of domestic production capacity.

We wish to express support for FY 1986 funding for the Center for Building Technology (CBT) and the Center for Fire Research (CFR) within the National Bureau of Standards. In this regard, the Association encourages federal support of activities of the National Bureau of Standards that are acknowledged to serve the interests of the public but which the cement industry itself, or others in the private sector, find difficult to justify financially. Partial financial support by NBS of the Cement and Concrete Reference Laboratory is an example of this kind of effort. The CCRL is supported both by NBS and by funds provided by the American Society for Testing and Materials (ASTM), and provides a nationwide inspection service for laboratories that test materials used in all types of concrete construction. Results of these inspections include an improvement in the quality of services provided by participating laboratories and consequent better construction for the public.

In general, the Portland Cement Association favors creation of incentives that will encourage maximum use of private funds for technological development related to the use of cement and concrete. We believe that federal funds should not be used to duplicate activities for which organizations and qualified personnel already exist in the private sector. To assure proper identification of projects that cannot be carried out by the cement and concrete industries, we believe that selection and implementation of federally supported research and test programs should be made only after study by knowledgeable representatives of both the public and private sectors. In a limited way, this kind of input is already being made by the National Institute of Building Sciences. Once programs are undertaken by organizations such as NBS, these should be permitted frequent review and, if necessary, modification to assure ultimate acceptance and use of results by the public and private sectors of the economy.

Respectfully submitted,

William J Young

William J. Young, President

BIA **Brick Institute of America** 11490 Commerce Park Drive, Reston, Virginia 22091 Phone: 703-620-0010

March 13, 1985

The Honorable Don Fuqua
U.S. House of Representatives
Washington, D.C. 20515

Dear Congressman Fuqua:

I am writing to you regarding the proposed elimination of funding for the Center for Building Technology (CBT) and the Center for Fire Research (CFR) during the budget discussion for fiscal year 1985. I would like to take this opportunity to express the concerns of the brick manufacturing industry.

The Brick Institute of America (BIA), a trade association which represents 85% of the total brick production in the United States, strongly supports the reauthorization of the CBT and the CFR within the National Bureau of Standards. Both of these programs undertake significant research activities that are invaluable to BIA and to the entire construction industry.

The BIA continually relies on the staffs at both the CBT and the CFR for expertise on whole building systems, materials and operations that the private sector cannot possibly provide because of the specialized nature of industry group capabilities.

Broad improvements in construction technology and responsible decisions affecting the construction industry can not be made without the comprehensive and impartial research, field work and laboratory experimentation which the CBT undertakes. The CBT provided the basic research work that has been incorporated into durability standards for brick and concrete. The Center has made outstanding contributions in the fields of energy conservation and passive solar energy technology, through the development of measurement techniques, standardized test procedures, computer modeling of energy systems and experimental work in the field of thermal mass. The earthquake research which the CBT has undertaken and its support of the Building Seismic Safety Council has proven essential to the building community.

The CFR's work on toxicity standards and on developing reliable methods for evaluating fire endurance of structural building systems has been invaluable to the industry. The problem of identifying and quantifying the flammable and smoke-producing characteristics of increasingly complex building materials and contents almost certainly cannot be adequately and impartially dealt with by any organization besides the CFR.

Due to broad-based industry support of both of the Centers as independent and trusted sources of unbiased technical data and technologies, and the Centers' track records of accomplishments within the industry, it is almost impossible for any private sector institution to replace the CBT and CFR in the integral role which the programs play in the promulgation and adoption of standards for the continued development of safe and efficient buildings.

We therefore strongly urge you to sustain adequate funding for the Center for Building Technology and the Center for Fire Research for fiscal year 1986 and allow these unique programs to continue their invaluable research efforts.

Finally, I must state that this annual exercise of requesting the help of your Committee to reauthorize funds for the Centers is becoming annoying and ludicrous. Isn't there some way your Committee can put this matter to rest once and for all?

We appreciate the consideration of our views in your decision.

Sincerely,

John P. Gleason, Jr.
President

JPG:ts

Chamber of Commerce of the United States of America
Washington

STATEMENT
on
REAUTHORIZATION of the CENTER FOR BUILDING TECHNOLOGY
and the
CENTER FOR FIRE RESEARCH
before the
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY AND SPACE
of the
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
for the
CHAMBER OF COMMERCE OF THE UNITED STATES
by
John S. Bush, Jr.
February 7, 1984

I am John S. Bush, Jr., Vice President, Government Affairs with the U.S. Gypsum Company. Accompanying me is William D. Kelleher, Manager Community Resources Section, Chamber of Commerce of the United States. My appearance today is on behalf of the Chamber, where I serve on the Construction Action Council as Chairman of its Building Technology Executives Group. The U.S. Chamber of Commerce is the nation's largest business organization with a membership of 200,000 consisting of business firms, local, state and regional chambers of commerce, and trade and professional associations.

The U.S. Chamber supports reauthorizations of the Center for Building Technology (CBT) and the Center for Fire Research (CFR) within the National Bureau of Standards. Continuation of both these organizations is vital to the entire construction community. They provide unique research capabilities and perspectives which cannot be duplicated in the private sector.

Center for Building Technology

The Center for Building Technology has undertaken a wide range of activities resulting in improvements in construction technology and the enhancing of the operation of the construction market place to the advantage of both industry and the consumer. Among the numerous accomplishments of the Center, I would specifically like to highlight the following:

- CBT developed a method for obtaining measured calibrated transfer specimens for use in conjunction with "the representative thickness" provision of the Federal Trade Commission (FTC) Labeling and Advertising of Home Insulation Rule. Test data and documentation were developed by CBT. This could not have been accomplished by private industry within the time limits prescribed by FTC. If the insulation industry had to comply with the FTC rule as written before the development of the guarded hot plate by CBT, increased costs for compliance, which would have been passed on to the consumer, were estimated to be $90 million per year.

- Conducted comprehensive investigation of the 1981 walkway collapse in Kansas City resulting in improved design and construction procedures.

- Developed performance criteria and test methods for protection of reinforcing bars in concrete salt-induced corrosion which will assist in more efficient bridge construction.

- At the suggestion of the American Society for Testing and Materials and the American Association of State Highway and Transportation Officials, CBT developed test equipment and procedure so that approximately 580 public and private laboratories across the country could conduct quality assurance testing for buildings and transportation facilities.

Construction is one of the nation's largest industries. It is estimated to account for 10 percent of our Gross National Product and 69 percent of our nation's wealth consists of the facilities that have been built to support and shelter all our social, economic and political activity. The CBT, through its field work, laboratory experiments and analytical research, provides the basic knowledge on the properties and operations of entire buildings and various building materials, systems and components. Without this basic knowledge which cannot be obtained through proprietary research and development, responsible and cost effective decisions cannot be made in construction.

The construction community is a highly diverse group consisting of building owners, manufacturers, designers, financers, developers, contractors, research and testing laboratories, standards developing organizations, regulatory bodies and federal, state and local governments. The CBT is a necessary institution within this community because it provides an objective and impartial source of information and research to all those who design, finance, build, operate and use our facilities.

The Center for Fire Research

The need for the Center for Fire Research remains as valid today as when it was established in 1974. The United States continues to lead the industrial world in the number of lives lost to fires and the increasing complexity of building materials and building contents make further research vital. CFR offers unique research facilities that deal with the highly specialized issues involved in fire research. It is extremely unlikely that any private sector institution could or would step in to provide either the equipment or interdisciplinary approach needed to address this problem.

Specific examples of the contributions by the Center follow.

- The National Bureau of Standards (NBS) Center for Fire Research (CFR) has been the guiding force in the development of testing equipment to quantify characteristics of materials which have been subject to fire. Once these characteristics have been quantified, a user of a material could rank order materials associated with the use of various products. Specific examples of standards researched by CFR in this area are:
  - ASTM Standard E 136 is a frequently used standard to describe combustibility of materials. The furnace used for this evaluation was developed by NBS/CFR.
  - ASTM Standard E 662 is used to describe the smoke-producing characteristics of a building material. This equipment was developed by NBS/CFR.

  - ASTM Standard E 162 and E 648 are used to describe flame spread characteristics of building material. Again, NBS/CFR led in the development of the equipment to evaluate these characteristics.

- CFR has developed a major program for fire protection methods in high-rise buildings which are vitally needed in light of the MGM Grand Hotel fire in Las Vegas. Specific work has been and is being done on sprinklers, smoke control, smoke detection and building design.

- The Center is the principal laboratory for the development of new test methods for flame spread and heat release which are necessary to cope with the very different burning behavior of plastics and other materials.

- CFR is the major developer of computer-based fire simulation models needed to estimate the impact of new materials and methods subject to fires.

National Voluntary Laboratory Accreditation Program (NVLAP)

While not part of this authorization bill, we also want to express our continued support for the National Voluntary Laboratory Accreditation Program (NVLAP). An efficient and effective system of testing laboratories is necessary for the practical application of improved product standards. We urge you to support adequate funding for the NVLAP program so that the knowledge produced by organizations, such as the Center for Building Technology and the Center for Fire Research, can be used in the field.

Conclusion

The nation faces numerous challenges in the construction industry in the next ten years. We must house the new families emerging from the baby-boom generation, rebuild our infrastructure and construct modern plants to restore economic vitality and provide jobs. The innovative work done by both these Centers can make important contributions to meeting the technological challenges in all these areas.

We urge you to support reauthorization of the Center for Building Technology and the Center for Fire Research. They have proven records of accomplishments and offer unique facilities and perspectives that cannot be replicated by the private sector.

APPENDIX V

STATE OF FLORIDA
OFFICE OF GOVERNOR BOB GRAHAM

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

March 1, 1985

Honorable Don Fuqua, M.C.
Second Florida District
2269 Rayburn House Office Building
Washington, D.C. 20515

Dear Congressman Fuqua:

I understand that a major budget cut has been proposed for the National Bureau of Standards, Institute of Computer Science and Technology (ICST). As a member of Florida's Information Resource Commission, the strategic information technology resources planning and policy-making organization for Florida state government, I am concerned about the proposed budget cut.

The Information Resource Commission has existed in Florida less than two years, yet the staff of the Commission have received assistance from the ICST on numerous occasions. In particular, the ICST has provided expertise in the areas of networking and security of computer systems. Most recently, Commission staff have been assisted by the ICST regarding public domain software which may be of significant use to the State and save considerable dollars.

As government becomes more and more reliant on information technology resources as tools to aid decision-making and assist in performing state functions, there is an even greater need for the unbiased technological expertise offered by the ICST. Therefore, I want to underscore my concern over the proposed budget cut.

If I can provide further information in efforts to obtain adequate funding for ICST, please let me know.

With kind regards,

Sincerely,

Bob Graham

Governor

BG/rmr

ROBERT T. MATSUI
3D DISTRICT, CALIFORNIA

COMMITTEE ON
WAYS AND MEANS

Congreſs of the United States
House of Repreſentatives
Waſhington, D.C. 20515

WASHINGTON OFFICE
231 CANNON HOUSE OFFICE BUILDING
WASHINGTON, D.C. 20515
(202) 225-7163

DISTRICT OFFICE
8058 FEDERAL BUILDING
650 CAPITOL MALL
SACRAMENTO, CALIFORNIA 95814
(916) 440-3543

March 15, 1985

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

Honorable Don Fuqua
Chairman
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Don:

As you examine the Administration's FY1986 budget submission, I would like to draw your attention to the proposed 50% cut to the funding of the Institute for Computer Sciences and Technology (ICST) of the National Bureau of Standards. Although ICST has a relatively small program, currently funded at only $10 million, I believe that it is a critical national resource for the development of urgently needed federal, national and international computer technology standards.

The current ICST program addresses areas of major national interest including software development and maintenance, database technology, computer security, and computer networking. Government-wide benefits of over $600 million are expected from only a portion of ICST's products in these areas. The proposed budget cut will result in the drastic reduction or elimination of much of this work.

In addition to providing informed leadership and guidance to the Federal Government, ICST serves the dual role of assisting the private sector. It promotes international standards that preserve U.S. industry's competitive position, while supporting users' needs for standards to increase productivity and reduce costs. It is uniquely situated to be an effective, impartial negotiator in the standards development process, providing a forum for mutual cooperation on standards that private companies can not provide themselves because of possible anti-trust impliciations.

This is the fourth consecutive year that a drastic funding cut has been proposed for the ICST. In the past, Congress has restored the proposed reductions, recognizing that no other organization can adequately provide these critically needed services.

THIS STATIONERY PRINTED ON PAPER MADE WITH RECYCLED FIBERS

ICST is very important to America's productivity and its competitiveness with the rest of the world. It is a program that pays for itself many times over. I hope that you will find it possible to support a continuation of the current level of funding for this essential effort.

Very truly yours,

ROBERT T. MATSUI
Member of Congress

DRAGON SYSTEMS, INC.
Chapel Bridge Park
55 Chapel Street
Newton, MA 02158
(617) 965-5200

March 4th, 1985

Representative Don Fuqua
Committee on Science and Technology
2321 Rayburn House Office Bldg.
Washington DC 20515

Dear Representative Fuqua,

There is a critical need for adequate funding in FY 1986 at the Institute for Computer Sciences and Technology, National Bureau of Standards.

For the past several years, I have been disturbed to learn of proposed cuts in the appropriations for this Institute. The realization of meaningful standards for computer science and technology is essential for both consumers and the creators of products. The standards-setting process cannot function effectively without the active and objective role played by the National Bureau of Standards. Cuts in NBS programs seriously threaten the proper functioning of the consensus standards process and the growth of technology in the United States.

I have been deeply involved with speech technology for many years. There has been recent rapid growth in this technology, and national and international standards-setting activities are now underway in the United States, the United Kingdom, and Japan. To a large extent meaningful progress in development of standards for speech technology is attributable to a Workshop on Standardization for Speech Technology which was sponsored in 1982 by the Institute for Computer Sciences and Technology at NBS, and to a continuing role in working with others in developing the standards that will be needed in this rapidly growing technology.

There is a critical need for objectivity in assessing the performance of an emerging technology. The recent National Academy of Sciences report of the Committee on Computerized Speech Recognition Technologies observed that "the importance of performance measurement techniques cannot be over-emphasized since they provide the data for decisions about system design and effectiveness." ICST/NBS programs to meet needs for objective procedures for performance assessment and to serve needs for speech data base standards and interchange provide important tools in making these decisions.

The proposed cuts in the ICST/NBS budget and program are dangerous. Abdication of government's responsibility for effective coordination in the development of critical standards and the relevant research threatens both the technology and our national strategic position by undermining our basis for objectivity.

I will appreciate your efforts to ensure that adequate funding is provided to support these programs.

Sincerely,

Janet M. Baker Ph.D.
President
Dragon Systems, Inc.

THE FLORIDA LEGISLATURE
JOINT COMMITTEE ON INFORMATION TECHNOLOGY RESOURCES

#48

REPRESENTATIVE ANNE MACKENZIE
CHAIR
SENATOR GEORGE STUART, JR.
VICE-CHAIR

EDWIN A. LEVINE, STAFF DIRECTOR
540 Barnett Bank Building
315 South Calhoun Street
Tallahassee, Florida 32301
Telephone (904) 488-4646

February 22, 1985

The Honorable Doug Walgren
House of Representatives
Subcommittee on Science, Research,
and Technology
2321 Rayburn House Office Building
Washington, D. C. 20515

Dear Congressman Walgren:

I understand that, once again, a major budget cut has been proposed for the Institute of Computer Science and Technology (ICST) in the National Bureau of Standards. I am most concerned about this based on the assistance Florida has received from the ICST, and the invaluable role they serve in the complex and dynamic field of high technology.

The ICST has been of tremendous assistance to Florida in the development of our own information resource policy for state government. They have provided committee members and staff with briefings on current technology and have been especially helpful to us in developing our security legislation in 1984 and in the long-range target of statewide network development.

One particular benefit of the ICST, which would be a great loss from the budget cut, is their work in developing standards. I believe the Federal government must continue to lead this effort. Standards in the computer industry will promote a competitive information technology market, increase innovation and permit the market forces to establish prices.

Once again, I want to convey to you my deep concern over these proposed budget cuts. The ICST has been and continues to be of tremendous assistance to Florida. I would hate to lose the unbiased technological expertise they offer.

If I can provide further information concerning Florida's use of ICST or assist in efforts to obtain adequate funding for ICST, please do not hesitate to call.

Sincerely,

Geo Stuart J.

Senator George Stuart, Jr.

GS:ep

State of Florida
INFORMATION RESOURCE COMMISSION
Office of the Executive Administrator

BOB GRAHAM
Governor, State of Florida, Chairman
DOYLE CONNER
Commissioner of Agriculture
GEORGE FIRESTONE
Secretary of State
BILL GUNTER
Insurance Commissioner
GERALD LEWIS
Comptroller
JIM SMITH
Attorney General
RALPH TURLINGTON
Commissioner of Education

#1

February 28, 1985

The Honorable Don Fuqua
Chairman, Committee on Science
and Technology
2321 Rayburn House Office Building
Washington, D. C. 20515

Dear Representative Fuqua:

This letter is to encourage your continued support of the Institute for Computer Sciences and Technology (ICST) in the National Bureau of Standards. I would like to inform you of some of the benefits this state has received through the efforts of the ICST.

The ICST operates a valuable outreach program for state and local governments. In the past several months Florida's Information Resource Commission and other state agencies have participated in this program. In the computer and information technology business staying up-to-date is crucial. The ICST's outreach program of telephone conference calls with national industry leaders and our counterparts in other states helps us stay informed. The programs are always timely and well presented, and they provide us with useful points of contact.

We have been actively involved with the ICST's computer security program. The ICST has benefited this state through its cooperative and generous support of our efforts in achieving and maintaining an adequate level of security for our computer operations. Through the work of ICST people like Dr. Dennis Steinhauer, Dr. Dennis Branstad, and Dr. Stuart Katzke, the State of Florida is better prepared to deal with the problems of computer security. We rely heavily on the ICST for expertise in security-related matters. Knowing that the ICST is only a "phone call away" has made it easier for us to address the state's computer security problems in a meaningful way. We have found the expertise available to us from ICST to be very broad-based and helpful.

With the support of the state Legislature, the Florida Information Resource Commission is pursuing the adoption of standards for computer communications. The National Bureau of Standards has been successful in this area, and we hope to have greater participation with the NBS in the future. We feel the standards work performed by NBS is deserving of your continuing support.

Executive Office
of the Governor/The Capitol
Tallahassee, Florida 32301

Resource Management - A path through the future

On behalf of the professional information resource community in Florida state government I encourage your continued support of the ICST and the NBS.

Sincerely,

Mike Hale
Executive Administrator

MH/pbb

cc: Honorable Bob Graham
Senator George Stuart, Jr.

Corporate Offices
21031 Ventura Boulevard
Woodland Hills, California 91364
(213) 887-9040 Telex 65-1399

February 25, 1985

informatics
general corporation

RECEIVED

Honorable Don Fuqua, Chairman
Committee on Science and Technology
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Congressman Fuqua:

My purpose in writing is to express my strong disapproval of the Administration's proposed cut in funding for the Institute for Computer Sciences and Technology (ICST) at the National Bureau of Standards. This is the fourth consecutive year that a drastic reduction has been proposed for ICST. In the past, the Congress has restored the proposed reductions, recognizing that no other private sector or government organization can adequately provide the services prescribed by its mission. This year the outcome is very much in doubt.

As Chairman and President of Informatics General Corporation, one of the country's leading independent computer software companies, I am convinced that by actively promoting international software, database and telecommunications standards, ICST plays a critical role in enhancing our trade posture and fostering the long-term welfare of our domestic high technology industries. It is essential that U.S. industry not be shut out of foreign markets by one-sided and protectionist standards, and ICST has done much to prevent this from happening.

As head of a major federal computer services and software contractor, I have observed that ICST's development of Federal Information Processing Standards (FIPS), which govern the acquisition and use of computers by federal agencies, has grown in importance and impact directly in proportion to the increase in federal outlays for this purpose--probably in the neighborhood of $20 billion annually for business data processing alone. Conservative estimates put the cost-benefit value of selected FIPS in the several-hundred-million dollar range, in return for a total investment of $10 million for the entire ICST program. In our eagerness to control the federal budget we must be careful not to sacrifice the very programs that help to make control possible.

Continued

Finally, as a former industry representative of the National Academy of Sciences Review Panel that oversees the work of ICST, I have been consistently impressed with the quality of the technical staff and the work they produce. For a tiny agency (fewer than 100 professional employees), their output and impact are indeed remarkable. ICST is an island of technical excellence and objectivity in the federal establishment that we can ill afford to lose.

The recommended cuts to the ICST budget would cripple its performance to the point of ineffectuality, and deal a major blow to efforts to improve our balance of trade and control the runaway federal deficit. I urge you to do everything in your power to prevent this from happening.

Sincerely yours,

Walter F. Bauer

Walter F. Bauer
Chairman and President

WFB:nb

25117 SW PARKWAY P.O. BOX 673 WILSONVILLE OREGON 97070 (503) 682-1606 TELEX 4994839 GSS Ui
GRAPHIC SOFTWARE SYSTEMS

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

March 5, 1985

The Honorable Don Fuqua
Committee on Science and Technology
2321 Rayburn House Office Building
Washington, DC 02515

Dear Mr. Fuqua:

My purpose in writing this letter is to express my strong concerns about the 50% funding reduction proposed for the Institute for Computer Sciences and Technology (ICST) of the National Bureau of Standards.

As Chairman of the American National Standards Institute Technical Committee X3H3 on Computer Graphics and a long-standing industry participant in America's voluntary standards program, I know how important it is to have strong and effective Government participation in this program, especially when we are faced with the active statutory participation in standards-making by the governments of western Europe and Japan.

ICST has a relatively small program but, nonetheless, is a critical national resource for the development of urgently needed federal, national, and international standards. As a part of the National Bureau of Standards, ICST is uniquely situated to be an effective, impartial negotiator in the standards development process. It promotes international standards that preserve U.S. industries' competitive position, while supporting users' needs for standards to achieve increased productivity and delivery of services at reduced cost.

They provide a forum for mutual cooperation on standards that private companies cannot provide themselves because of possible anti-trust implications.

The current program is addressing areas of major interest including software development, database technology, flexible media such as disks, computer graphics, security procedures and technology, and computer networking. The ICST has provided very informed leadership and guidance to the Federal Government in these areas as well as informing and assisting the private sector. Work in each of these areas would be drastically reduced or eliminated under the proposed budget reduction.

This is the fourth consecutive year that a drastic funding cut has been proposed for the ICST. In the past, Congress has restored the proposed reductions, recognizing that no other private sector or governmental organization can adequately provide these critically needed services.

ICST is very important to America's productivity and its competitiveness with the rest of the world. We hope that, within the constraints of the total budget, it will be possible to continue the current level of funding for this essential effort.

Sincerely yours,

Peter R Bono

Dr. Peter R. Bono
Director, Strategic Technology

PRB/emb

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IEEE COMPUTER SOCIETY

VICE PRESIDENT FOR STANDARDS

Mr Fletcher J Buckley
RCA
Mail Stop 101-210
Moorestown NJ 08057
(609) 778-3606 office
(609) 424-5436 home

12 March 1985

The Honorable Don Fuqua
Committee on Science and Technology
2321 Rayburn House Office Building
Washington, DC 20515

Dear Congressman:

The purpose of this letter is to express our strong concern about the proposed funding reductions in the budget of the Institute for Computer Software Technology (ICST) of the National Bureau of Standards. ICST has been an outstanding contributor in the area of software engineering standards. In particular, its publications, FIPS PUB 38 and FIPS PUB 64, have provided landmark guidance to those of us who have been struggling in this new technology.

The ICST also has active and continuous programs in the language standardization area and in the interface between the volunteer standards organizations and the government organizations such as the Department of Defense that prepare their own standards. The current program is addressing areas of many interests, including data base technology, computer graphics, computer security procedures and networking.

The proposed 50% reduction in funds will cause all of this work to stop at the precise time when the fifth generation computer efforts from Japan and other countries are becoming matters of increasing importance.

Your special consideration in this area would be strongly appreciated.

Sincerely,

F. J. Buckley

FJB/d

IEEE THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC

AIM
ADVANCED INFORMATION MANAGEMENT INCORPORATED
Computer security and privacy

February 28, 1985

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

The Honorable Don Fuqua, Chairman
Committee on Science and Technology
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Representative Fuqua:

My purpose in writing this letter is to express strong concern about the funding reduction proposed for the Institute for Computer Sciences and Technology (ICST) of the National Bureau of Standards.

It is my understanding that the Administration's budget proposal for FY 1986 recommends a $5 million cut in the authorization for the National Bureau of Standards' Institute for Computer Sciences and Technology (ICST) and that this budget cut would result in a complete elimination of the ICST computer security program. If this should happen, we would lose an important source of guidance and assistance to both the private and public sectors -- as well as a number of other important, non-security programs of the Institute.

For several years, the ICST has been at the forefront of technical research and development activity for protecting computer systems and has provided the public and private sectors with effective and practical guidance on how to secure computer-based information. Their program encompasses research and development of security standards, transfer of technology to potential implementors and vendors, and assistance to users of security technology. Organizations in private industry have long looked to ICST for guidance and have adopted many of their standards and guidelines.

It is ICST that was responsible for the issuance of the Data Encryption Standard and for significant security research and guidance contributions in such areas as personal computer security, risk analysis, EFT message authentication, personal identification, contingency planning, and computer security certification. The Institute has also been actively involved in computer security professional activities, which serves as a major technology transfer function to the public and private sectors.

It is my belief that the proposed budget cut would result in a serious loss to the nation. The relationship between the problems of abuse of public computer systems and the programs of the ICST should not be lost in your deliberations. The technological standards they provide apply directly and immediately to combatting this serious situation. Consequently, I am making you aware of its significance and strongly suggest that you consider restoring the proposed budget cut for ICST.

Sincerely,

Robert Campbell
Robert P. Campbell, CDP
President

RPC:ik

1988 Opitz Boulevard • Woodbridge, Virginia 22191 • (703) 643-1002

RCI : 17

ROBERT COURTNEY, INC - 914-338-2525 - BOX 836 - PORT EWEN, NEW YORK 12466

ROBERT H. COURTNEY
President

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[illegible] 1985

COMMITTEE ON SCIENCE
AND TECHNOLOGY

February 26, 1985

Honorable Don Fuqua
Chairman, Committee on Science
and Technology
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Congressman Fuqua:

The 1986 budget reduces by $5 million the budget for the National Bureau of Standards' Institute for Computer Sciences and Technology (ICST). There can be no possible economy in this step. Every dollar by which the ICST budget is reduced must appear multiplied many times over in the budgets of the other federal agencies which have been supported in the past by ICST.

The ICST provides a center of competence in electronic data processing for the other civil agencies of the federal government. If the services currently provided by ICST are further diminished, each of the previously supported agencies must attempt to either acquire the cadre of diverse skills, talents, and disciplines necessary to the continued conduct of their current data processing operations or simply do without them. The acquisition of those skills by most such agencies is an impossibility. They cannot attract such people. If they did, it would result in gross duplication of effort and an equally gross waste of valuable and scarce capabilities. The latter option, doing without, will only assure an increase in the already rapid rate at which most non-DoD federal data processing systems are becoming technically obsolete.

Although I am fully appreciative of the need to reduce the federal budget, cosmetic reductions, such as the proposed cuts in the ICST budget, which can only result in far greater expenditures elsewhere or more costly operation of key agencies should not be among the ways chosen. The ICST budget has been reduced in each of the past four years and data processing in the federal government has been increasingly impaired by those reductions. Let's end this false economy now.

Your support for preservation of the 1985 ICST funding level is urgently needed.

Sincerely,

Robert H. Courtney, Jr.

Offices and Representation Worldwide

MANAGER SOFTWARE PRODUCTS INC
131 Hartwell Avenue
Lexington, MA 02173 3126
☎ (617) 863 5800
TWX 710 326 6431 MSPLEX

March 21, 1985

Mr. Don Fuqua
Committee on Science and Technology
2321 Rayburn House Office Building
Washington, DC 20515

Dear Mr. Fuqua:

My purpose in writing this letter is to express our strong concerns about the 50% funding reduction proposed for the Institute for Computer Sciences and Technology (ICST) of the National Bureau of Standards.

ICST has a relatively small program which, nonetheless, is a critical national resource for the development of urgently needed federal, national, and international standards. As a part of the National Bureau of Standards, ICST is uniquely situated to be an effective, impartial negotiator in the standards development process. It promotes international standards that preserve U. S. industry's competitive position, while supporting users' needs for standards to achieve increased productivity and delivery of services at reduced cost.

They provide a forum for mutual cooperation on standards that private companies cannot provide themselves because of possible anti-trust implications.

The current program is addressing areas of major interest including software development, database technology, flexible media such as discs, computer graphics, security procedures and technology, and computer networking. The ICST has provided very informed leadership and guidance to the Federal Government in these areas as well as informing and assisting the private sector. I believe that the work in each of these areas would be drastically reduced or eliminated under the proposed budget reduction.

This is the fourth consecutive year that a drastic funding cut has been proposed for the ICST. In the past, Congress has restored the proposed reductions, recognizing that no other private sector or governmental organization can adequately provide these critically needed services.

ICST is very important to America's productivity and its competiveness with the rest of the world. We hope that, within the constraints of the total budget, it will be possible to continue the current level of funding for this essential effort.

Yours sincerely,

President and Chief Executive Officer

F
DB

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[illegible]
COMMITTEE ON SCIENCE
AND TECHNOLOGY

EMULEX

EMULEX CORPORATION
3545 Harbor Boulevard, P.O. Box 6725, Costa Mesa, CA 92626
Telephone: (714) 662-5600 TWX: 910-595-2521

13 March 1985

Mr. Don Fukua
Chairman of Committee on Science and Technology
2321 Rayburn House Office Building
Washington, D.C. 20510

Dear Mr. Fukua:

As a manufacturer of Small Computer Systems Interface (SCSI) products, we at Emulex are interested in the continued participation of the National Bureau of Standards in I/O Interface standards. We understand that a Congressional Proposal is being discussed to cut in half the budget for the Institute of Computer Science and Technology, and that this could mean the end of ICST support for Interface standards in favor of Networking standards.

May we remind you that the Computer Peripherals business today is a 20 to 30 billion dollar business and that in international trade it is at least as great as the Computer Networking business. At present more than 50 companies have committed to building SCSI products and there are predictions of over 500,000 SCSI controllers to be sold next year.

We feel that the NBS has provided a valuable service to us as an uninvolved party with no possible financial gain. It serves as a storehouse of knowledge concerning the details of the standard and of the SCSI market.

Emulex supports and appreciates the efforts of the National Bureau of Standards. We urge you to see to it that the ICST budget is sufficient to cover the contiuation of the Interface standards, especially the Small Computer Systems Interface.

Sincerely yours,

EMULEX CORPORATION

Stephen W Frankel

Stephen W. Frankel
President

European Headquarters: 10th Floor, Cory House, High Street, Bracknell, Berkshire, UK
Telephone 0344-84234 Telex 849 781 EMULEX G

March 22,1985

The Honorable Doug Walgren
House of Representatives
Subcommittee on Science, Research and Technology
2319 Rayburn House Office Building
Washington, DC 20515

Dear Sir:

Speech technology is rapidly becoming an important component in computer science and technology. Within the past several years many commercial products have become available to augment the man-machine interface using speech. The expected growth of this technology will significantly impact the nature of our use of computer technology.

As a professional with many years of experience in the development and application of speech products, and as Editor-in-Chief of Speech Technology magazine, I recognize the value of the program in speech I/O technology at the National Bureau of Standards' Institute for Computer Sciences and Technology. This program serves an important role in meeting needs for testing procedures, and research and development of standards in cooperation with industry.

I understand with regret that proposed budget cuts for fiscal year 1986 may threaten the ability of NBS to continue to provide leadership in standards development for computer science and technology. To my way of thinking, continued support of standards development is extremely important, and this represents an inappropriate reduction in federal support for science and technology.

Please take the necessary steps to see that these programs are maintained at at least the current levels of funding. Thank you for your attention to this issue.

Sincerely,

James W. Glenn
President, Glenn Associates, Inc.
Editor-in-Chief, Speech Technology magazine

GLENN ASSOCIATES, INC. • 3824 NORTH DITTMAR ROAD • ARLINGTON, VIRGINIA 22207 • (703) 536-7122

THE
GEORGE
WASHINGTON
UNIVERSITY
School of Engineering and Applied Science/Washington, D.C. 20052

*Department of
Electrical Engineering
and Computer Science
(202)676-6083*

RECEIVED

February 26, 1985

The Honorable Don Fuqua, Chairman
Committee on Science and Technology
2321 Rayburn House Office Building
Washington, DC 20515

Dear Representative Fuqua:

I am writing as a computer scientist, an educator, and an advisor to both Congress and the Executive Branch to express my concern about the funding reduction proposed for the Institute for Computer Sciences and Technology (ICST) of the National Bureau of Standards.

It is my understanding that the Administration's budget proposal for Fiscal Year 1986 recommends a $5,000,000 cut in the ICST authorization and that this budget cut would result in the complete elimination of the ICST Computer Security Program. If this should happen an important source of guidance and assistance to many federal government agencies and to the private sector would be lost. And there is no other agency in government which could easily fill the void.

I know personally about ICST work in both computer security and risk analysis. I have written three books on the topic and numerous papers, and regularly direct both students and government workers from many agencies who contact me to ICST and its publications. I know also that their ongoing work in computer security, done by a minimal but competent staff, addresses very serious issues which are going to become more serious in the years to come with the proliferation of microcomputers and "hackers" (and the resultant lack of computer security in these systems). The Institute has also been actively involved in computer security professional activities which serve a major technology transfer function to the public and private sectors.

The proposed budget cut is penny-wise and pound-foolish. The security losses government agencies alone would suffer because they would have no one readily available for advice would greatly exceed the so-called "savings". I hope you will consider restoring the proposed budget cut.

I would be more than happy to discuss this with you or your staff if they desire further information.

Sincerely,

Lance J. Hoffman
Associate Professor

LJH:bab

EDP AUDITORS ASSOCIATION, INC.
National Capital Area Chapter
P. O. Box 50127
Washington, D.C. 20004

February 28, 1985

The Honorable Don Fuqua
Chairman
Committee on Science and Technology
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Fuqua:

This letter is in response to a proposed 50% funding cut in FY1986 to the budget of the Institute for Computer Sciences and Technology at the N.B.S.

I hope to keep it mercifully short since I am sure that you receive a lot of this sort of thing.

I am President of the non-profit EDP Auditors Association in Washington, D.C. Our mandate is to bring more coherence, integrity, security, economy and control to the management of data processing resources through research and education.

Our over 250 local members (out of a worldwide organization of over 10,000) can be found in almost every major corporation, university, federal and local government agencies, consulting firms, etc., in the D.C. area.

I suppose that we could make quite a technological case as to the need for what the ICST does regarding standards and guidelines in various areas of high technology. But basically it comes down to the fact that they bring about significant unseen (and often unmeasurable) financial economies by doing, in effect, what "Japan, Inc." has always done so well but on a much larger scale - helping government and industry "get its act together" before a lot of funds are wasted in truly useless competition.

The assistance of the ICST even to our small organization has hardly been abstract; they have sent representatives to our meetings on several occasions, have spoken at length, distributed useful state-of-the-art publications, given demonstrations,

EDP AUDITORS ASSOCIATION, INC.
National Capital Area Chapter
P. O. Box 50127
Washington, D.C. 20004

The Honorable Don Fuqua
February 28, 1985
Page Two

etc. Next month, for example, they will be reviewing and demonstrating about 200 security devices applicable to the exploding microcomputer environment. We know of no private group that does this sort of thing due to the problem of vested interest. This knowledge alone could possibly prevent real losses elsewhere in the government itself.

I sympathize with the need for Federal fiscal restraint, and I know that everybody wants cuts to come out of "the other guy's budget". I simply submit for your consideration whether the effective elimination of this organization is a true economy.

Some agencies just consume dollars; others help generate them. Standards bring about economies that ultimately benefit exports, employment, etc.

Your thoughtful consideration of this matter is appreciated.

Sincerely,

Richard Houck

Richard A. Houck

88 Thoreau Court
Yorktown Heights, NY 10598

March 29, 1985

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

Honorable Don Fuqua, Chairman
Committee on Science & Technology
2321 Rayburn House Office Building
Washington, DC 20515

Honorable Fuqua:

My purpose in writing this letter is to express my serious concern about the funding reduction which has been proposed for the Institute for Computer Sciences and Technology of the National Bureau of Standards, and to urge you to restore those funds to their FY 1986 budget.

It is my understanding that the Administration's budget proposal for FY 1986 recommends a $5 million cut in the authorization for the Institute for Computer Sciences and Technology (ICST), and that this budget cut would result in virtually the complete elimination of the ICST computer security program. If this should happen, an important source of guidance and assistance to both the private and public sectors, would be lost.

The ICST has been at the forefront of technical research and development activities for protecting computer systems for a number of years, and has provided both the public and private sectors with effective and practical guidance on how to secure computer-based information. Their program encompasses research and development of security standards, transfer of technology to potential implementors and vendors, and assistance to users of security technology. It is the ICST that was responsible for the issuance of the Data Encryption Standard and for substantial research and publication of standards and guidelines in such critical areas as personal computer security, risk analysis, EFT message authentication, personal identification, contingency planning, and computer security certification. Organizations such as ours, in private industry have long looked to the ICST for guidance and have adopted many of their standards and guidelines.

According to the Commerce Department's news release of February 4, except for the international networking of computers, "the voluntary standards process would be relied upon for other computer-related standards." Having the perspective of spending the last 12 1/2 years in the computer and data security field, I can tell you that the voluntary standards process has not worked for computer security-related standards in the past, and it simply cannot successfully address this critical need. Further, organizations in both the public and private sectors are putting an unbelievable amount of time and effort - at a staggering cost - into solving problems that ICST-developed standards could readily address. The irony is that these costs are so diverse and widespread as to be almost impossible to measure with any degree of accuracy, thus making it extremely difficult to justify the ICST's activities and budget. If these costs could be measured, I am fully confident that an increased ICST budget could be easily justified, and would be proposed and approved with little or no dissension.

No other private or governmental organization can, or will, provide such critically needed activities if the ICST's funding level is reduced as has been proposed. It is particularly disturbing to me to learn that this is the fourth consecutive year that the Administration has proposed a major reduction of the ICST program.

It is my belief that the proposed budget cut would result in a serious loss to the nation. Consequently, I am writing to make you aware of its significance and recommend that you give serious consideration to restoring the proposed budget cut for the ICST, or even more appropriate, increasing its budget for FY 1986.

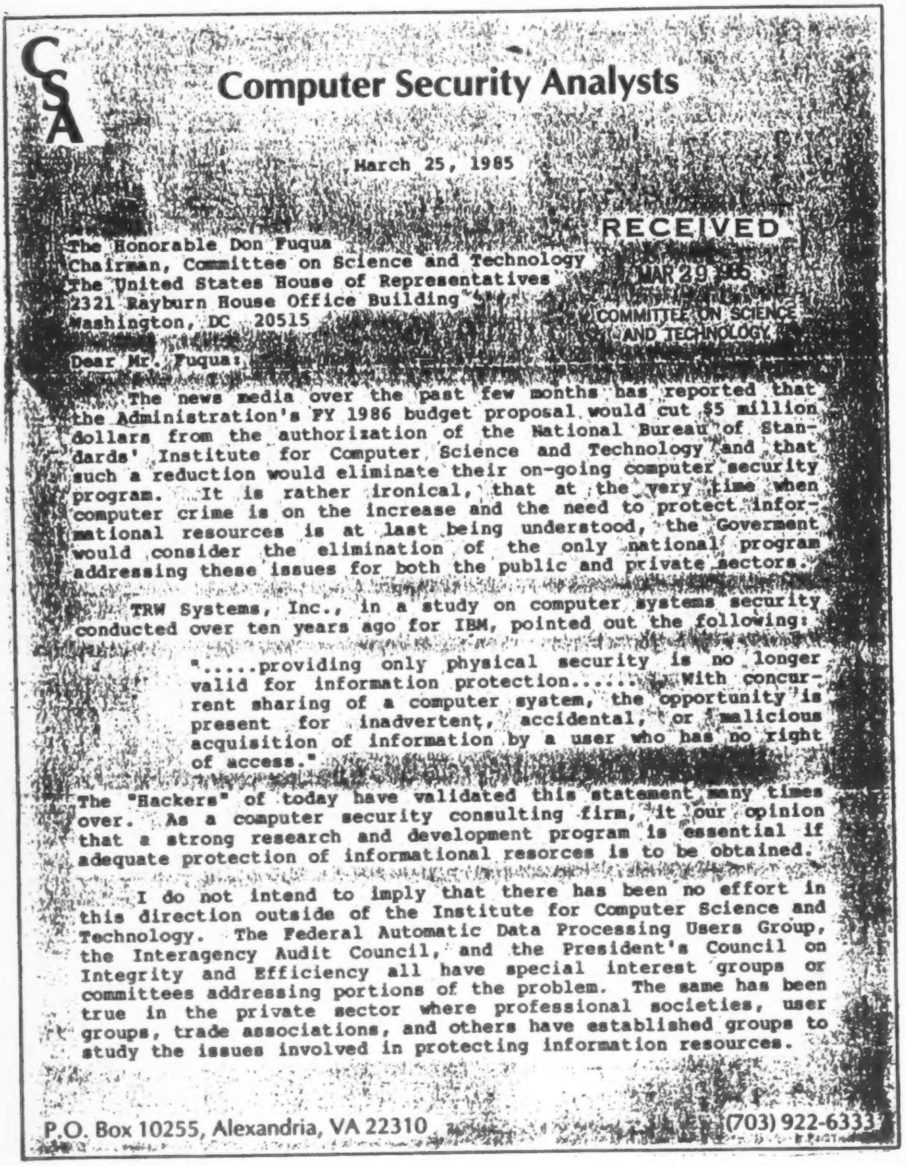
If you have any questions, or I can provide any additional information, I can be reached at (203) 794-4316.

Very truly yours,

Rick Koenig

R. C. Koenig, Manager
Computer & Data Security
Union Carbide Corporation

RCK:an
0037C



CSA

Computer Security Analysts

March 25, 1985

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MAR 29 1985
COMMITTEE ON SCIENCE
AND TECHNOLOGY

The Honorable Don Fuqua
Chairman, Committee on Science and Technology
The United States House of Representatives
2321 Rayburn House Office Building
Washington, DC 20515

Dear Mr. Fuqua:

The news media over the past few months has reported that the Administration's FY 1986 budget proposal would cut $5 million dollars from the authorization of the National Bureau of Standards' Institute for Computer Science and Technology and that such a reduction would eliminate their on-going computer security program. It is rather ironical, that at the very time when computer crime is on the increase and the need to protect informational resources is at last being understood, the Goverment would consider the elimination of the only national program addressing these issues for both the public and private sectors.

TRW Systems, Inc., in a study on computer systems security conducted over ten years ago for IBM, pointed out the following:

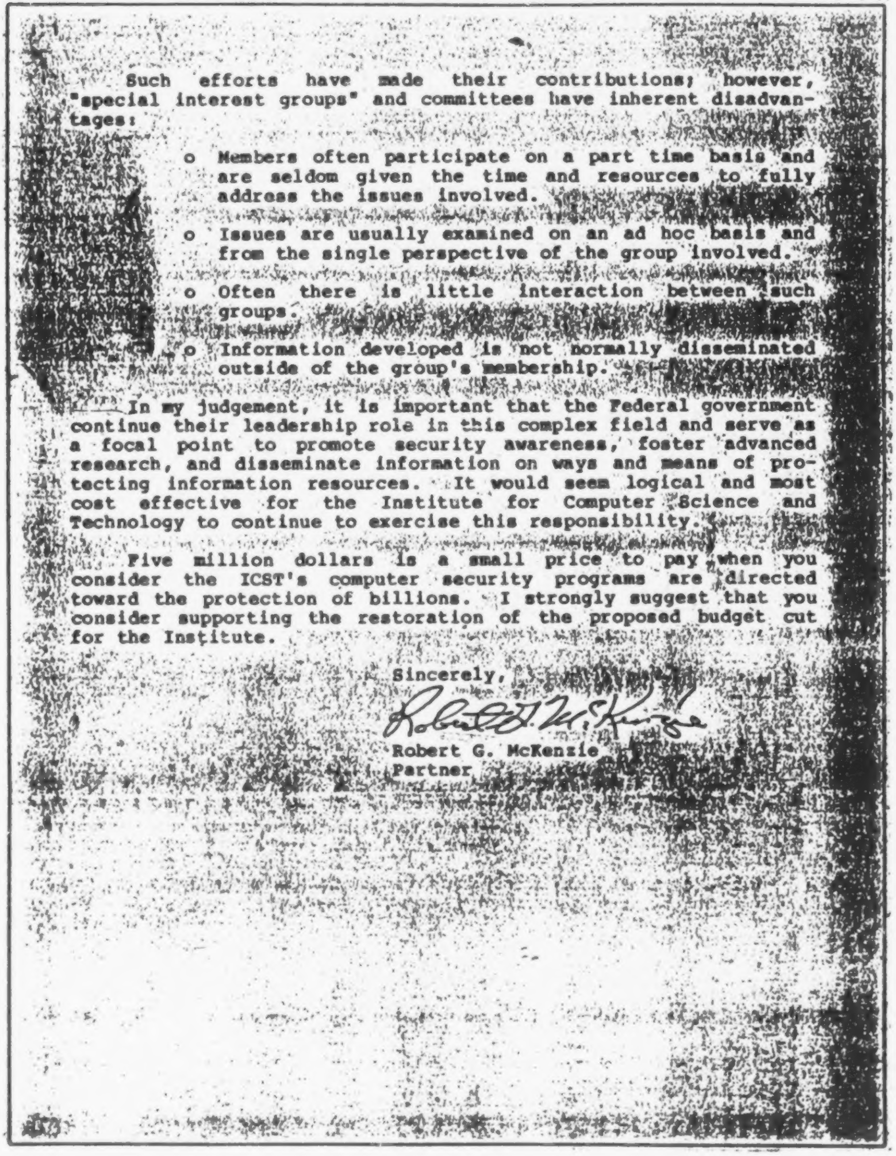
> ".....providing only physical security is no longer valid for information protection...... With concurrent sharing of a computer system, the opportunity is present for inadvertent, accidental, or malicious acquisition of information by a user who has no right of access."

The "Hackers" of today have validated this statement many times over. As a computer security consulting firm, it our opinion that a strong research and development program is essential if adequate protection of informational resorces is to be obtained.

I do not intend to imply that there has been no effort in this direction outside of the Institute for Computer Science and Technology. The Federal Automatic Data Processing Users Group, the Interagency Audit Council, and the President's Council on Integrity and Efficiency all have special interest groups or committees addressing portions of the problem. The same has been true in the private sector where professional societies, user groups, trade associations, and others have established groups to study the issues involved in protecting information resources.

P.O. Box 10255, Alexandria, VA 22310 (703) 922-6333

BEST AVAILABLE COPY



Such efforts have made their contributions; however, "special interest groups" and committees have inherent disadvantages:

- o Members often participate on a part time basis and are seldom given the time and resources to fully address the issues involved.
- o Issues are usually examined on an ad hoc basis and from the single perspective of the group involved.
- o Often there is little interaction between such groups.
- o Information developed is not normally disseminated outside of the group's membership.

In my judgement, it is important that the Federal government continue their leadership role in this complex field and serve as a focal point to promote security awareness, foster advanced research, and disseminate information on ways and means of protecting information resources. It would seem logical and most cost effective for the Institute for Computer Science and Technology to continue to exercise this responsibility.

Five million dollars is a small price to pay when you consider the ICST's computer security programs are directed toward the protection of billions. I strongly suggest that you consider supporting the restoration of the proposed budget cut for the Institute.

Sincerely,

Robert G. McKenzie

Robert G. McKenzie
Partner

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RECEIVED

ROLF T. MOULTON
29449 GATES MILLS BOULEVARD
PEPPER PIKE, OHIO 44124

February 24, 1985

Congressman Don Fuqua
United States House of Representatives
Washington, DC 20515

RE: NBS-ICST Budget Restoration

Honorable Don Fuqua:

I would like to express my concern about the funding reduction proposed for the Institute for Computer Sciences and Technology (ICST) of the National Bureau of Standards. I would strongly urge you to consider restoration of the ICST budget because ICST provides an essential service to both private industry and government.

The Institute for Computer Sciences and Technology's guidance, particularly the many FIPS Publications, extremely valuable to me in developing the City of New York's computer security program while I was Director of the City's Computer Security Services Unit of the Department of Investigation. More recently, I have found the same guidance equally valuable and applicable to private industry in my position as manager of computer security at a large company in Ohio.

The ICST is the best, and perhaps only, truely impartial source of trusted referrence material for private industry and government computer security practitioners and auditors- experienced as well as inexperienced. It is extremely important to have it remain as a leader in providing information on the protection of computer related asset systems which are needed for the strength and protection of this nation and its industries.

I strongly urge you to consider restoring the full budget for ICST because it is in the best interest of the nation. I will be happy to provide additional information to you towards that purpose if it will be of assistance to you.

Sincerely,

Rolf T. Moulton

Rolf T. Moulton

Albuquerque Federal

RECEIVED

[illegible]

COMMITTEE ON SCIENCE
AND TECHNOLOGY

February 26, 1985

Honorable Don Fuqua
Chairman, Committee on Science
and Technology
2321 Rayburn House Office Building
Washington, DC 20515

Dear Mr. Fuqua:

Funding for ICST is of utmost importance to the financial community. Without ICST it is questionable where Electronic Funds Transfer would be today.

Though I agree the Federal budget should be reduced, I cannot believe a mere five (5) million to this organization is worthy of consideration. The cost to the private sector would be untold, in addition to creating anti-trust implications.

I ask your serious consideration of this matter when it comes to you.

Sincerely,

Gerald S. Ralston
Vice President
Data Processing

GSR:jd

NEW MEXICO'S FAMILY FINANCIAL CENTER ○ Data Processing Department 3420 San Pedro NE, P.O. Box 25000, Albuquerque, NM 87125 • (505) 883-3100

DIGITAL EQUIPMENT CORPORATION
Maynard, Massachusetts 01754

Harvey L. Weiss
Vice President, U.S. Area

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

March 15, 1985

The Honorable Don Fuqua
Chairman, Committee on Science and Technology
2321 Rayburn House Office Building
Washington, DC 20515

Dear Mr. Fuqua:

I am writing on behalf of Digital Equipment Corporation to express our concern regarding the proposal in the Administration's FY86 budget which would reduce by 50% the funding for the institute for Computer Science and Technology (ICST) of the National Bureau of Standards (NBS). Digital Equipment Corporation is deeply concerned about this issue. We believe that ICST is a critical national resource for the development of urgently needed Federal, National, and International ADP and Telecommunications Standards, and should have it's programs maintained as fully as possible.

As a part of the National Bureau of Standards, ICST is uniquely situated to be an effective, impartial negotiator in the standards development process. It promotes international standards that preserve U.S. industry's competitive positions in the world market, while supporting users' needs for standards to achieve increased productivity and delivery of services at reduced cost.

The ICST program is addressing areas of major interest to Digital Equipment Corporation. These include:

- Hardware Interfacing
- Database Technology
- Computer Networking
- Languages and Software
- Security Procedures and Technology
- Computer Graphics
- Recording Media

I am concerned that work in these areas will be reduced or eliminated under the current proposed reduction.

This is the fourth consecutive year that a drastic funding cut has been proposed for the ICST. In the past, Congress has restored the proposed reductions, recognizing that no other private sector or governmental organization can adequately provide these critically needed services.

A suggested replacement for ICST standards activity is to have the private sector assume the responsibilities for a number of selected areas of development. It is not known what programs would be dropped or retained or how this effort would be organized and funded. However, we strongly believe that it would require several years and many dollars for any new organization private or otherwise to reach the level of productivity and Service that the ICST now provides. In addition, it is very doubtful that any privately operated group could offer the non-proprietary technical view points and positions now being provided by ICST.

I strongly urge that the ICST budget for FY 86 be maintained at the same level as FY 85 and that ICST as an organization, be allowed to continue their very needed mission without interuption.

Very truly yours,

Harvey L. Weiss

ng

AOG Systems Corporation

☐ Harvard Depot Road
P.O. Box M
Harvard, MA 01451
(617) 456-3517

☐ 298 Great Road
P.O. Box 1503
Littleton, MA 01460

☒ P.O. Box 2308
Fairfax, VA 22032

February 19, 1985

Representative Doug Walgren, Chairman
Subcommittee on Science, Research
and Technology
2319 Rayburn House Office Building
Washington, DC 20515

Dear Sir:

My purpose in writing this letter is to express my strong concerns about the 50% funding reduction proposed for the Institute for Computer Sciences and Technology (ICST) of the National Bureau of Standards.

ICST has a relatively small program which, nonetheless, is critical to the successful development of urgently needed federal, national, and international standards. ICST is uniquely situated to help preserve U.S. industry's competitive position, while supporting both the public's and the government's needs for standards which increase productivity and reduce cost.

The current program is addressing areas of major interest including dictionary and database systems technology, software development methods, security procedures, computer graphics and computer networking. As the Chair of the American National Standards Committee responsible for developing the Standard for Information Resource Dictionary Systems (IRDS), a critical element in Paperwork Reduction Act and the Reform 88 activities, I am well aware of the role that ICST has played in the development of a Standard for IRDS. Without ICST, the IRDS Standard which is now being prepared for national and international review would not exist for the foreseeable future. The ICST has provided informed leadership and has served as a prime focal point for standards concerned with dictionary systems and the other areas mentioned above. Work in each of these critical areas would be drastically reduced or eliminated under the proposed budget reduction.

This is the fourth consecutive year that a drastic funding cut has been proposed for the ICST. In the past, Congress has recognized that there is no other private sector or governmental organization which can adequately provide these critically needed services, and has restored the proposed reductions. I recognize the difficult choices which must be made in order to significantly reduce the budget deficit. I hope, however, that it will be possible to continue the current level of funding for ICST, whose role is essential to increasing America's productivity and competitiveness with the rest of the world.

Sincerely,

Anthony J. Winkler

Dr. Anthony J. Winkler
Chair, ANSI/X3H4

NORMAN J. REAM
311 AVENIDA SAN JUAN EAST
SAN CLEMENTE, CALIFORNIA 92672

March 7, 1985

The Honorable Doug Walgren
Chairman, Subcommittee on Science,
  Research and Technology
Room 2241 Rayburn House Office Building
Washington, DC 20515

My dear Mr. Congressman:

First I would like to express my deep appreciation for the time from your busy schedule that you allowed me to discuss with you my concern over the plight of the Institute for Computer Sciences and Technology as it involves the budget cutback process.

I recognize that as Chairman of the Subcommittee on Science, Research and Technology, and from the hearings that you have conducted over the past four years, you are well informed of the problems, and I am most thankful that you have safely guided ICST through three very difficult budget years. I would hope that once again this year you and your Committee will be successful in your support of this most important activity.

It is very difficult to express in depth the problems that might be created in the Executive Branch in event this small group of scientists at NBS might be eliminated. However, with the huge expenditures that are made within the Executive Branch in support of information processing, it is not difficult to understand that the small budget of ICST would appear to be one that could be sacrificed. The reverse, of course, is true; and it is impossible to conjecture the problems that would arise in event they were sacrificed.

Secondly, the contribution that they make to our international trade area is also very vital to our national interests. They are, as you know, the Federal government representative at the ISO standards activities, and as such they have demonstrated their ability to prevent other foreign nations from pushing through international standards that would not be in our best national interests. Once again, this type of action does not surface to the uninformed, but nevertheless is vital to our interests.

Third, at this point in time we find that industry in the private sector of our nation is also depending heavily on ICST to furnish them standards and other types of guidance that will assist them in their management and productive activities. It is unfortunate that many of those members of our private sector who are both appreciative of and are making use of the developments of ICST have not come forward to express their support. Nevertheless if they were aware of the problems, I am sure they would gladly lend their name.

As the first Director of the Institute, I have watched their growth and have been in a position to assess their contributions to the state of the art; and I can only say that if they are decimated by this current budget process, we, as a nation, will lose a very important asset.

During my stay in Washington I was able to obtain a copy of the points that will probably be brought forth by those who are attempting to privatize ICST's networking standards and testing activity, and I am attaching to this letter a copy of that document. It would appear that this is probably the basis upon which Congressman Lujan will introduce legislation for the privatization process. The document, however, is extremely weak, and is certainly subject to severe challenge; and in fact, in my opinion, is misrepresentation of fact. In most instances I would not bother to forward it to you; however, in this immediate case I think you should have an opportunity to review it. I am also sending to you, and I will send a copy to Jim Turner of your Committee staff, a copy of those areas in which I feel ICST should presently be heavily engaged. However, I recognize that due to budget considerations, certain of these projects cannot be undertaken. However, that does not lessen their importance. I have also attached a one-page summary of ICST's current in-house program.

Interestingly, the present Administration in late February issued management directives that will require Federal agencies to "obtain a minimum 10% return on investment for all computer technology and to cut software maintenance costs by 25%." It is ludicrous that OMB would issue such directives when at the same time they are decimating the activities of those scientists who would contribute very heavily to making OMB's objectives possible. I am enclosing an article from Computer World that sets forth the public announcement of the directives.

Once again I wish to thank you for the courtesies that you extended to me, and I surely hope that your actions and those of your Committee members will be successful in supporting ICST and giving them at least a minimal operating budget for Fiscal Year 1986. In event there is any further information that I might furnish to you, or any assistance that I might lend to Mr. Turner and/or other members of your staff, I hope that you will not hesitate to call upon me. I plan to be back in Washington within the next few weeks, and I will take the opportunity to call your office in event you wish to speak with me.

Sincerely,

Norman J. Ream

Norman J. Ream

NJR:aq
enc.

INSTITUTE FOR COMPUTER SCIENCES & TECHNOLOGY

CURRENT IN HOUSE PROGRAM

SOFTWARE

Develop standards and guidelines for the management and control of software development projects, the analysis and design of software, acquisition and testing, documentation, and software maintenance. Includes standards for high level programming languages (COBOL, Fortran, Basic, Pascal, Ada) and lower level languages (C). Produce guidelines for the selection and use of traditional programming languages, languages used for advanced applications (e.g., Lisp, Prolog), and emerging "fourth generation languages" (e.g., Nomad, Mantis, Focus).

SECURITY

Produce computer security standards for such areas as computer system physical security, access controls, and data encryption to protect information in transmission between systems. Develop guidelines for risk analysis and management addressing the establishment and maintenance of computer security programs, selection and implementation of program components, and the use of technology-based tools to support security and related activities.

NETWORKS AND ARCHITECTURES

Produce computer system and network interface standards to permit the interconnection of computer system and network components from different manufacturers. Includes network protocols, magnetic media standards, and communications protocols specific to local area networks. Develop measurement methods for evaluating performance of prototype implementations, and the conformance of products to emerging standards.

DATA MANAGEMENT

Develop standards for commonly used data management software to support the interconnection of software facilities from different vendors. Produce guidelines on the selection and use of data management software, data administration, database application design and conversion. Develop methods and techniques for evaluating data management software performance and conformance of products to emerging standards.

SYSTEMS

Develop standards and guidelines for the selection and evaluation of systems alternatives, including stand-alone, micro-based systems, multi-user systems, networked micros and other decentralized system architectures, computer-based office systems, and computer graphics systems. This area also includes the development of technology forecasts.

ADDITIONAL NEW PROGRAM AREAS THAT SHOULD BE UNDERTAKEN BY THE INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY

It is imperative that ICST ultimately be granted budget that will allow for their entry into additional project areas that must currently be excluded.

Currently, because of budget restrictions, ICST can only attempt to investigate and gain knowledge of newly developing areas or areas of concern.

The following are those areas where attention to ICST program development is necessary:

- Computer Aided Design/Computer Aided Manufacturing (CAD/CAM)

In the development of CAD/CAM systems, which stems from design automation, the integration of research, engineering, manufacturing and management information through the interlocking of the databases involved is the most difficult and important objective to be accomplished. The CAD/CAM concept, and the limited development to date far over-reach the concept of robotics and/or only plant automation.

The major problem today is inadequate data base management systems (DBMS) and supporting software. The currently identified DBMS needs have not been fully addressed and it is recognized that software requirements have not been fully identified. Extensive research is required.

ICST is uniquely situated and qualified to enter into the CAD/CAM effort. Such efforts will expedite our National capability which will result in increased productivity in civilian government, military, and private industry. Total annual savings would be in the billions of dollars.

- Artificial Intelligence and Expert Systems (AI/ES)

It has been reported that the Department of Defense plans to spend approximately $600 million in this area over the next five years.

The DoD efforts will be directed primarily to military requirements, though much of their efforts must be in basic research, and it is doubtful that their efforts and/or output will be fully available to other civilian agencies.

The ICST interest and activity would be in the selection and evaluation of software systems that result from developments (e.g. knowledge-based data systems and decision support systems).

ICST should have a parallel program to participate with DoD and to translate the findings and results into non-military areas.

There is also a direct compatible relationship between CAD/CAM and AI/ES.

- Distributed Processing

  This project would address the design, development and management of applications which are built on top of computer networks (e.g., distributed data management and control, distributed operating systems, distributed systems security).

- Integrated Office information Systems

  This project could be referred to as "Office Automation" and would be directed to support the acquisition and use of advanced technology in the office (e.g., document interchange, the processing of text/graphics/voice data).

- Advanced Systems Architecture

  Directed to selection and evaluation of emerging technology (e.g., parallel processing, high-speed computing, very large storage systems, intelligent systems components).

- Advanced Application Development Technology

  Project for acquisition and use of powerful applications development tools and techniques (e.g., very high level languages, reusable software).

- Software Quality

  Project to define documentation, testing and performance requirements for software and software controlled systems, without requiring that proprietary product information be revealed.

- Standards to Improve Management of Federal Computerized Model

  Standards to improve the management of Federal computerized models cover such areas as documentation, specification, development and procurement. This activity responds to a specific need cited by GAO in a report to the Congress.

N.J. Ream
3/6/85

OMB: Improve DP investments, cut software costs

By Mitch Betts
CW Washington Bureau

WASHINGTON, D.C. — The Reagan administration last week issued management directives that will require federal agencies to obtain a minimum 10% return on investment for all computer technology and to cut software maintenance costs by 25%.

The U.S. Office of Management and Budget's (OMB) "Management for Fiscal Year 1986" report said the moves are needed to "recapture the government's position as a leader in the efficient and productive use of information technology." To accomplish this, the OMB established the following three management principles:

- Agencies will be required to document at least a 10% return on their information technology investments. "Investments in information technology must be treated in a businesslike manner, and the gains from automated projects should be monitored and realized," the OMB report said.
- Agencies will be required to implement standards that foster open systems of communication and permit the exchange of information among systems. The OMB said it will undertake a project to determine whether to adopt interconnection standards from the International Standards Organization.
- Greater reliance will be placed on the acquisition of commercially available software to reduce the government's dependence upon locally developed, customized software. Software costs today amount to 60% of federal computer expenditures, compared with 20% in 1965, the OMB said.

On the subject of software management, the OMB said that because the federal government continues to custom-develop 90% of its software, the transition to modern, efficient hardware is inhibited by large volumes of custom code that require conversion.

"The private sector also is investing more in off-the-shelf software packages than in custom-developing new software. Such packages have the advantages of being maintained by the vendor and do not require substantial in-house technical staff," the OMB report said.

The OMB said agencies will be asked to reduce their software maintenance costs by 25% and their software staffs by 5,000 full-time positions over the next three years.

Consistent with this initiative, the Internal Revenue Service and the Federal Aviation Administration will be converting systems to high-level languages to increase portability, and the Veterans Administration is studying the feasibility of converting its "antiquated" insurance software to a modified commercial package, the OMB said.

New Cobol Standard Pushed in U.S. Govt

NBS Wants Agencies To Adopt "8X" Voluntarily

The Federal Department of Commerce wants a better Cobol for the government, which it feels should adopt the newly-revised voluntary industry standard, the American National Standards Institute's proposed Cobol-8X.

The revised Federal Information Processing Standard would supersede FIPS 21-1, reflecting what Commerce calls major changes and improvements.

Comments concerning the adoption of the proposed revision should be sent to Director, Institute for Computer Sciences and Technology (Attn: Proposed FIPS Cobol), National Bureau of Standards, Gaithersburg, MD 20899. Comments are due by March 20.

- Communications and computer technologies have converged to the point where it is no longer possible to tell which is which -- particularly when computers talk to other computers over distance.

- Until the break-up, AT&T set and tested telecommunications networking standards -- chaos now reigns.

- No one sets the standards for computers and related products -- if you need a system you either get "locked in" to a single manufacturer or else spend a lot of money making the various parts compatible. The American National Standards Institute has the voluntary standards-approval responsibility but its process is so cumbersome that it may take over five years to issue a standard and even then the standard is simply a confirmation of a market-tested de facto standard. If no de facto standard exists, no official standard is issued.

- The Institute for Computer Sciences and Technology at NBS sets and tests the procurement standards (including networking) for the Federal Government. Most States and many large private sector computer/telecommunications users voluntarily follow those standards.

- The technology is moving so quickly that ICST is unable to keep up with it. In order to keep abreast of the technology, the ICST networking program would need about $15M more than the President recommends for FY86. This is unlikely to be forthcoming from Federal sources.

- Our foreign trade in computers, computer services, and telecommunications depends on non-discriminatory networking standards. Absent a strong U.S. presence in the international standards-making bodies, foreign governments use networking standards as non-tarrif trade barriers in order to help their own industries.

- In as-yet separate activities, some of the private sector users and some of the manufacturers have met to discuss supporting networking standards outside of government.

  --The user issue is productivity
  --The manufacturer issue is competitiveness in world markets

- **Privatization of ICST's networking standards and testing activity appears both feasible and desirable.**

  -- Preliminary analysis indicates that the networking program would require about $4M in Federal funds the first year of privatization, $2M the second year, and only fee-for-service thereafter.

-- The Federal government would support the privatized organization as a user, under the same terms as the other supporting users.

— The privatized organization would require the Federal imprimatur as negotiator in the international arena and as advisor to the State department. There is precedent in the Federal arrangement with ANSI.

-- The privatized organization would have to be formed so that no one manufacturer or small set of manufacturers would dominate.

TESTIMONY BEFORE THE HOUSE SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

COMMITTEE ON SCIENCE AND TECHNOLOGY

February 7, 1984

Mr. Chairman and Members of the Subcommittee:

I am Shirley Prutch, Vice President, Martin Marietta Data Systems. I have served on the ICST Evaluation Panel for the last three years and now chair the Panel. Thank you for inviting me to talk with you today. To make sure that we are dealing within the same framework, I would first like to review ICST's legislative mandate and tell you what I believe to be its implications. ICST's primary charter comes from the "Brooks Act" which directs the Department of Commerce to develop standards and guidelines which lead to "the economic and efficient purchase, lease, maintenance, operation and utilization of automatic data processing equipment" within the Federal Government (PL 89-306) and to conduct whatever research is necessary to meet that goal.

The Panel has found that ICST must engage in a broad range of activities in order to fulfill this mandate since most organizations could write standards and guidelines, for that is relatively easy to do. One problem, however, comes when those standards and guidelines are translated into real equipment to be used by ordinary people under normal work conditions. Proper research is required in consultation with the manufacturing industry if industry is to build to the standard. Similarly, if staffs have not been given appropriate guidance, very few agencies will be able to use the equipment "economically and efficiently." ICST, therefore, spends a great deal of time working with the vendors and the agency users and, the Evaluation Panel believes, does so with very good effect.

Problem two comes when you convert from equipment which has been custom-built to the specifications of one particular user (in this case the Federal Government) to equipment which can be bought off-the-shelf by all users. It is only when you get to an "off-the-shelf" position that real economies can be realized. The Federal Government, even with its enormous resources, cannot bring that position about by itself. The Federal Government buys about 6 percent of the ADP (automatic data processing) equipment sold in the United States and even though that represents a huge federal investment it is not a sufficient market to cause standardization. In order to do that, ICST must aggregate a market of State and local governments and industry ADP users. Therefore, the Institute works with many of the large users in order to educate them and to ascertain their needs. ICST then brings those needs to the national and international voluntary standards committees where, to a large extent, the vendors are the dominant players.

As the unbiased leader of an unofficial coalition of users, ICST is able to demonstrate that a worthwhile market exists, and as a premier research agency, ICST is able to lead the voluntary organizations toward technically sound standards that result in off-the-shelf products--to the benefit of all of us.

This method of working has a number of important side effects--all of them good. In the international arena, ICST has been instrumental in preventing foreign competition from using standardization as non-tariff trade barriers. By ensuring that technical specifications do not discriminate against U.S. vendors, the Institute has effectively protected our trade interests. More importantly, ICST's standardization work has also laid the groundwork for significant innovation by the computer and telecommunications industry. Perhaps it is appropriate to spend a few moments discussing the relationship between standardization and innovation.

Thinking through and in discussion with various colleagues about this subject, I became informed of a draft of a contractor's report which had been prepared for the Office of Technology Assessment. According to my colleague, the report distinguishes between product standardization and system standardization as well as between proprietary information and non-proprietary information. (This is an important point in the discussion of ICST's role within the standardization world, because some people have suggested that the private sector can do the job.) A product is generally standardized through market-place usage; a number of different products are marketed and users gradually converge on the ones whose properties are most useful. This happens over a long period and official standardization takes place late in the process--usually after a de facto standard exists, i.e., the product which meets most users' needs is the product around which convergence happens. A system, however, requires standardization much earlier because basic connections must be in place before system innovation can be explored; meaning that the market testing, which precedes the standardization of a product, generally does not take place when the issue is a system. This is where ICST's testing laboratories assume an important role. The proposed standard interfaces for computer/communications systems are tested in the laboratories to make sure that they "work." In cooperation with individual firms, proprietary systems are tested to make sure that they "work" with the interfaces. With that assurance, industry can go about its process of system innovation with confidence.

The industry relies on ICST to provide a "neutral" ground for the testing of these interface standards because such standards deal with nonproprietary matters. Certain information and research results are proprietary to the companies which develop them. Other things, standards among them, are shared by an entire industry. Individual companies put most of their R&D resources into those things which are proprietary because that is where they get the greatest return on their individual investments. There are very few mechanisms available for cooperative participation in the research and development of nonproprietary material--partly because of our anti-trust laws and partly because the companies, in fear of jeopardizing their competitive positions, will not divulge to one another the proprietary information needed to develop standards which must be used by all. ICST provides a trusted mechanism, as well as the synergy, for building the nonproprietary knowledge base which is essential to proprietary innovation.

Having presented what I have been told is the basis of the report prepared for the Office of Technology Assessment, you might choose to read that report. I look forward, naturally, to being able to do so as well.

Let me return now to ICST's method of working. I referred earlier to its usual method of working through the voluntary standards committees.

Occasionally, though, the voluntary process is simply too slow to satisfy the immediate needs of the Federal agencies. In those cases, ICST tries to develop a "quick fix" that will be consistent with the direction of the voluntary committees but will, at the same time, solve the worst of the agencies' problems.

An example in point is one which the Panel applauded in last year's review of ICST's activities. That is the work that ICST did with the U.S. Navy in developing document interchange specifications. We all know of horror stories about trying to use the product of one word processor with a word processor of a different make. (As an aside, I relied on an electronic office automation system in preparing this testimony rather than assuming I could find compatible word processing equipment in the various cities I have been in over the past two weeks.) If we can manage the interchange at all, we are apt to get a fifteen page paragraph with very funny looking margins. ICST worked with the Navy and a number of different vendors in developing some specifications that would solve many of the problems in effecting the interchange and the vendors have agreed to build to those specifications. This means that when the Navy procures its word processors in the future, it will not have to make a choice between being "locked into" a single vendor or putting up with the incompatibilities among products. This will save the Navy millions of dollars. Those savings will be magnified, of course, as other government agencies adopt the specifications; and the savings would be astronomic if U.S. industry should adopt the specifications.

That brings me to my request to this Subcommittee. Please broaden ICST's mandate to specifically cover work with industry ADP users. As I mentioned before, ICST works with industry as a by-product of its mandate to help Federal agencies. For all its efforts, though, ICST cannot reach much of the consumer industry and we need ICST's leadership if we are to attain the level of productivity that the new computer and communications technologies make possible.

An area of improvement that the Evaluation Panel three years ago urged upon ICST was to tell their message, i.e., what they were doing, to the non-Federal Government world. The Panel was impressed with the work going on in ICST in many areas and felt that it was important that this non-biased group publicize their message to not only State and local government but to the consumer industry as well. ICST heard that recommendation and again was applauded by the Panel for their efforts in making their work better known. They have published news bulletins, sponsored forums as well as teleconferences and have generally been more vocal in what they were doing. This "tooting of their own horn," so to speak, was a very important aspect of making their non-biased synergy work. The panel feels very strongly in this area because ICST can provide a leadership which cannot come from industry itself.

For one thing, we are too diverse to produce a common leader. For another, many are not in the ADP business and as consumers, would not have the technical expertise required for genuine leadership. And for a third, we operate under the same non-disclosure restrictions as does the computer industry. As sometimes competitors, the possibility of sharing proprietary data is non-existent. But we can and do trust ICST. A broadening of ICST's mandate would allow them to treat user-industry relations as more than a by-product of their primary mission. Any increase in the productivity of American industry as a whole will not only strengthen America's trade position but will greatly benefit the American consumer.

There is one more matter which we need to cover--namely, ICST's budget. I have noticed that in the past, this Subcommittee has asked witnesses to comment on the Institute's funding. I would like to stress that I am not as conversant with the details of this budget as I would be if I were fighting for the budget of my areas within my corporation, but I would like to make two points. The first is that with the proposed five million dollar budget, ICST simply cannot fulfill its current mandate.

If five million is all that is available, we would do better to disband ICST and thereby publicly state that the mandate is not needed rather than waste five million dollars with results that cannot be even close to acceptable. Having said that, I would expect a question from you asking what I believe might be an appropriate budget and again I would tell you I am not close to the details so I would hedge my answer by saying that as of five years ago, ICST's budget, in today's dollars, would be about fifteen million. Five years ago, it appears that that authorized funding allowed ICST to operate effectively. ICST today is much stronger because of their reputation than they were five years ago so I feel strongly that we, as taxpayers, as well as consumers, would get more bang for our bucks. Therefore, a roundabout answer to an unasked, at this point, question is that I respectfully suggest that you consider a fifteen million dollar level as appropriate for ICST's needs. With this level of funding, ICST can be held accountable for producing results that can be measured and will add to the productivity level of our government and our industries.

Thank you. I would be happy to answer any questions you might have.

APPENDIX VI

UNIVERSITY OF MARYLAND
CENTRAL ADMINISTRATION
OFFICE OF THE PRESIDENT

ADELPHI, MARYLAND 20783
(MAIN OFFICE) (301) 853-3601

BALTIMORE, MARYLAND 21201
(301) 528-7000

March 2, 1985

The Honorable Douglas Walgren, Chairman
House Science and Technology Subcommittee
on Science, Research and Technology
2319 Rayburn House Office Building
Washington, DC 20515

Dear Congressman Walgren:

We would like to express our enthusiastic support for two initiatives contained in the National Bureau of Standards budget recently submitted by President Reagan and now before your Subcommittee for consideration.

The first initiative is the proposal to develop a Center for Cold Neutron Research at the National Bureau of Standards Research Reactor in Gaithersburg. "Cold" neutrons provide a technique which is essential for research into the fundamental properties of solids, and is unique for characterizing the behavior of novel materials such as glassy metals, polymers and biological systems which are so important in technical applications. We believe that the development of this center is vital not only for the important science that can be performed, but also for the scientific and technical training of future scientists.

We should also like to point out that the possibilities at NBS are unique. It has the only reactor in this country that was originally designed to provide "cold" neutrons, and hence, if implemented, it would provide by far the best facilities in the U. S. in this important area of research and technology.

The second initiative is to provide a science base for industrial applications of biotechnology. The field of biotechnology is developing with startling rapidity and gives promise for major industrial applications in agriculture, pharmaceuticals, biosensors, bioelectronics, and chemical processing. The National Bureau of Standards has the responsibility for establishing national standards for this rapidly emerging technology which will depend critically upon accurate measurements. Cooperation with universities and industry throughout the nation will be necessary to protect the public interest and to make optimal progress in the applications of biotechnology. Biotechnology offers an opportunity for major advances in health and in agricultural and industrial production and is especially deserving of your support.

We very much hope that your committee will look favorably upon these proposals.

Respectfully yours,

John Toll

John S. Toll
President

JST:ah

cc: Dr. John Brooks Slaughter
Dr. William E. Kirwan
Dr. Frank J. Kerr
Dr. Edward F. Redish
Dr. Jeffrey Lynn
Dr. David S. Sparks
Dr. Rita R. Colwell
Dr. Patricia S. Florestano

ALUMINUM COMPANY OF AMERICA
ALCOA TECHNICAL CENTER
ALCOA CENTER, PA 15069
(412) 339 6651

1985 March 05

Congressman Doug Waldren
2441 Rayburn House Office Building
Washington, DC 20515

Dear Congressman Waldren:

Alcoa is committed to maintaining its worldwide leadership in aluminum technology while expanding efforts in the development of other advanced material systems. Development and maintenance of a leadership position in materials technology requires sophisticated techniques for microstructural and microchemical analysis. Among these, neutron scattering is a unique and valuable tool that is emerging in importance, partly through the efforts of the National Bureau of Standards. The addition of a cold neutron facility at NBS would enhance their capabilities in three areas of importance to Alcoa:

(1) The use of Al-Li alloys in commercial and military aerospace vehicles would result in major improvements in performance. The development of these alloys requires knowledge of the location of Li in the microstructure. Unfortunately, most microanalytical techniques cannot detect Li. However, neutron depth profiling is extremely sensitive to Li. The addition of the cold neutron facility would allow 3-D depth profiling of Li and the ability to study the precipitation of Li-bearing phases in situ.

(2) Superplastic aluminum alloys could also be used to improve the performance and decrease the production cost of aerospace alloys. Understanding grain boundary cavitation behavior is necessary to improve superplastic aluminum alloy technology. Neutron scattering is an excellent method for study of the nucelation and growth of these voids. The increased resolution and sensitivity which would result from the addition of the cold neutron facility would make it possible to do in-situ kinetic studies of cavitation in superplastic alloys. In a similar fashion, studies of sintering in advanced ceramics could be carried out at the proposed facility.

(3) Neutron scattering is a powerful technique for studying the magnetic structure of magnetic materials. The addition of the cold neutron facility could make a valuable contribution to Alcoa's programs in magnetic media. Also, the ability to study molecular motion, binding interactions and phase separation with neutron scattering would aid in Alcoa's development of catalyst and polymer technology.

In summary, the addition of a cold neutron research facility at the National Bureau of Standards would provide a unique opportunity to study the microstructure and microchemistry of metals, ceramics and polymers. Such a facility would provide U.S. industries with a technique to study advanced materials which is generally not available to foreign competition. This facility would also assist the U.S. in the development of those materials which are vital for national security. Alcoa strongly supports the addition of a cold neutron facility and would plan to interact with NBS scientists in this area through the research of Dr. Roberto Rioja and Dr. Craig Jensen.

Sincerely,

P. R. Bridenbaugh

P. R. Bridenbaugh,
Vice President-Research & Development

PRB:agf

HARVARD UNIVERSITY

DEPARTMENT OF PHYSICS

LYMAN LABORATORY OF PHYSICS
CAMBRIDGE, MASSACHUSETTS 02138

February 22, 1985

The Honorable Don Fuqua
House Committee on Science & Technology
United States Congress
Washington, D. C. 20000

Dear Congressman Fuqua:

I understand that the House Committee on Science and Technology will soon be considering support of the NBS Center for Cold Neutron Research.

I very much hope that you and other members of Congress will support this badly needed research center. This facility is essential if the U.S. is to avoid falling too far behind the Europeans, who have for many years had an excellent cold neutron research facility at Grenoble, France, which they are now upgrading to be even better. As a result the center of research in this field has moved heavily toward Europe.

The facility is needed not only for fundamental research but also for materials research with extensive industrial applications. Even though some of the research is done by U.S. citizens including myself by visiting Grenoble, European industry by virtue of its closer proximity to where the research is done benefits much more than does U.S. industry at present. The NBS Cold Neutron Facility is urgently needed to maintain US strength in this area.

Sincerely yours,

Norman F Ramsey

Norman F. Ramsey
Higgins Professor of Physics

NFR/cad

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THE TECHNOLOGICAL INSTITUTE
DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

TELEPHONE (312) 492-3537
(312) 492-3587

February 21, 1985

Mr. Douglas Walgren, Chairman
Subcommittee on Science, Research and Technology
House Committee on Science and Technology
2319 Rayburn House Office Building
Washington, DC 20515

Dear Mr. Walgren:

I am writing to urge your support for funding for the National Bureau of Standards program to upgrade their neutron scattering facilities through the construction of a neutron guide hall and improved instrumentation.

I am soliciting your support because (1) of great personal frustration at my inability to carry out a vital segment of my own (largely government sponsored) research program because of the inadequacy of the available neutron facilities; and (2) the sorry state of neutron scattering facilities in the US has left the American scientific community at a serious disadvantage vis-a-vis their European counterparts.

(1) I have been engaged for several years in neutron scattering research in the field of materials science. This work, sponsored by NSF and DOE, has gained international recognition. It deals with problems involving fatigue failure and microstructural stability in metals, both topics of considerable technological importance. Most of this research was carried out in France, since no American facility is capable of successful execution of the experiments. Access to the French facility now is largely denied to Americans because it is heavily oversubscribed by West European users, so my research has come to a standstill. The proposed upgrading of the NBS facility will permit this type of work to be carried out in the US.

(2) A large segment of research in characterizing metals, polymers, advanced ceramics, magnetic behavior, etc., is closed to US science because none of the US neutron scattering facilities even approach state-of-the-art capabilities.

The Bureau of Standards has a first rate group of scientists, internationally known for excellence in research, who have come up with carefully thought out plans and who will be able to carry them through. The cost is modest; the benefit to the American scientific and technological community enormous. We cannot afford not to have such a facility in the US in this time of scientific and technological competition.

Sincerely yours,

J R Weertman
J. R. Weertman
Professor
Materials Science and Engineering

/lk

ES 3178 REV 1/81
DUPONT
ESTABLISHED 1802
E. I. du Pont de Nemours & Company
INCORPORATED
Wilmington, Delaware 19898

CENTRAL RESEARCH & DEVELOPMENT DEPARTMENT
EXPERIMENTAL STATION

February 26, 1985

The Honorable Douglas Walgren
Chairman
Subcommittee on Science, Research and Technology
of the Committee on Science and Technology
2319 Rayburn House Office Building
Washington, DC 20515

Dear Mr. Walgren:

I read with considerable interest in a recent issue of Chemical and Engineering News that funding for the National Bureau of Standard's COLD NEUTRON RESEARCH FACILITY (CNRF) was receiving favorable consideration from the federal government. This letter is written in support of CNRF.

Neutrons have the unique property in scattering and spectroscopic studies of allowing one to make measurements in "in situ" environments. It is thus possible to define at an atomic level the response of a system under the same temperature, pressure, and chemical environment as is used in real world operating conditions.

The low energy probing which is possible with cold neutrons permits one to examine in detail the diffusion of molecules or atoms in solids, the reorientation and absorption of molecules in catalysts, polymer configurations and dynamics, layered or "packaged" electronic materials, and protein structure and motion in solution.

CNRF would provide a research capability which is not available elsewhere in North America, the closest alternative being in Grenoble, France. The research directions of modern technology are particularly well represented at NBS in the areas of ceramics, alloys, electronic materials, polymers, biomolecules, and catalysts.

During the past four years, Du Pont scientists have worked interactively with the staff at NBS on research projects with considerable success. The CNRF would permit the extension of that collaboration into numerous new areas of mutual interest. Cold neutron measurement technology would be of great importance to the research needs of science in industry as well as academics in the United States.

Thank you for your consideration of this project.

Sincerely,

Galen Stucky

Dr. Galen D. Stucky
Research Leader

nb

Monsanto

PHYSICAL SCIENCES CENTER

Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-1000

March 20, 1985

Mr. Don Fuqua, Chairman
House of Representatives Committee on Science & Technology
2269 Rayburn House Office Building
Washington, D.C. 20515

Sir:

I am writing you to encourage you to support funding of the biotechnology initiative in the National Bureau of Standards in the President's 1986 budget. This initiative is important in helping the National Bureau of Standards (and the National Measurement Laboratory specifically) to be responsive to the important industrial trends in the United States, particularly in the chemical, biological and medical fields.

As a member of the Review Committee for the Center for Analytical Chemistry in the National Measurement Laboratory, I am well aware of the importance of the biotechnology initiative and am personally convinced of the strong interest and desire to utilize these resources effectively that is present in the staff of the Center for Analytical Chemistry. I encourage your careful consideration and support of this initiative.

Sincerely,

William E. Koerner

William E. Koerner, Director
Physical & Environmental Sciences Centers
Corporate Research and Development Staff

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

HP GENENCHEM

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[illegible] 18 [illegible]

COMMITTEE ON SCIENCE
AND TECHNOLOGY

14 March 1985

Honorable Don Fuqua
Chairman, House Committee on Science & Technology
Room 2269, Rayburn Office Building
Washington, D.C.

Dear Representative Lujan:

I am writing to you in support of the pending request for funds to support a biotechnology program at the National Bureau of Standards. The company I represent is a new venture formed by Hewlett-Packard Company and Genentech, Inc. Our charter is to develop lab instrumentation which will be especially useful to those scientists and engineers who are developing new processes in the biosciences.

Having been associated with the instrument business for twenty years, I have had ample opportunity to witness first-hand the critical role that NBS and the National Measurement Lab play in helping to define and standardize analytical methodology. NBS maintains leading edge technical programs in a number of the classical analytical sciences. In addition, the availability of standard reference materials has been of great help to ensure the accuracy of the measurements made with the equipment we provide. A good example of this is the availability of air pollution standards which helped to standardize measurements made on auto emissions, an important issue in the 70's.

At issue in this decade is the rapid develoment of biotechnology and the commercialization of new processes to manufacture drugs, chemicals, foods and other important products. It is entirely within the charter of the Department of Commerce to support this development. The National Bureau could play an important role in helping industry to make a commercial success of the new biotechnology. With proper funding, NBS can develop not only reference standards, but also methodology and a reservoir of technical expertise for the biosciences.

I urge you to support the pending request for funds to develop this technology at NBS.

Sincerely,

HP GENENCHEM

R. Board

Robert Board
President

RB/jk

460 Point San Bruno Blvd
So. San Francisco
CA 94080
415 872 7057

Lockheed
A Division of Lockheed Corporation
Marietta, Georgia 30063

March 8, 1985

Honorable Doug Walgren, Chairman
House Sub-Committee on Science,
Research, and Technology
2441 RHOB
Washington, D. C. 20515

Dear Mr. Chairman:

I am taking this opportunity to urge you to support the National Bureau of Standards FY 1986 Congressional Budget Initiative regarding "Scientific and Technical Research" services. Recognizing the thrust of President Reagan's economic and budget concerns, please note that this request is not for additional funding. The concern and reason for the request is that the "Fundamental Physical Measurements and Standards (Process and Quality Control) Program" increase, which is presently identified at $1.994 million, be authorized at this level. It is imperative that this budget item not be allowed to be dropped or traded off in favor of other initiatives.

The Product Assurance Calibration Activity here at the Lockheed-Georgia Company has been gravely concerned with the degradation of the National Bureau of Standards' (NBS) role in maintaining and developing measurement standards for the United States. Because of budget restrictions, the support of their National Measurement System has been degraded to a level that is no longer acceptable to industry. Mandated projects that Congress has assigned to NBS, without adjusted budget and personnel ceilings, have consumed significant amounts of their budget, management, and manpower at the expense of their basic standardization function, a function which by law only they can provide. The renewed emphasis on industrial quality control, increased productivity, and the increased use of high technology in the manufacture of sophisticated products is placing greater demands on the NBS measurement services.

The NBS was established in 1901 by an Act of Congress known as the "Organic Act", and states in part "to be responsible for the custody, maintenance, and development of the National Standards of Measurements and the provision of means and methods for making measurements consistent with those standards." The Bureau is the national center for excellence in measurement oriented research and development of fundamental constants, as well as, new methods of basic measurements. Without adequate funding, the NBS cannot keep abreast of the "state-of-the-art" developments in metrology, let alone be the Standards leader for our nation.

Your assistance in this matter will be greatly appreciated.

Sincerely,

L. A. Wilson, Director
Product Assurance & Safety

LAW/RML/cd

Vacuum Pumps and Components
Leak Detectors
Analytical Systems
LEYBOLD-HERAEUS
LEYBOLD-HERAEUS
VACUUM PRODUCTS INC.

#68 10 MAR 1985

March 8, 1985

The Honorable Doug Walgren
House of Representatives
2117 Federal Building
1000 Liberty Avenue
Pittsburgh, PA 15222

Dear Mr. Walgren:

I am writing in regard to the National Bureau of Standards 1986 fiscal year budget request. The NBS will require sufficient funding in order to provide adequate service in areas of measurement standards and services that are not now adequately covered due to current funding.

One area in particular is the area of fundamental physical measurements and standards. This area could provide new and improved measurement services to industry and governmental agencies that will help to increase the effectiveness of industrial processes and quality control.

I urge you to support the FY86 NBS budget request. Do not allow it to be dropped or traded off in favor of other initiatives.

Thank you for your consideration in this matter.

Very truly yours,

William R. Dezorzi

William R. Dezorzi
Product Manager

WRD:cll

cc: Senator Paul Laxalt (NV)
Chairman-Appropriations Committee

Senator Slade Gorton
Subcommittee on Sci., Tech. and Space

5700 Mellon Road · Export, PA 15632 · Telephone: (412) 327-5700 · TWX 510-468-5418

APPENDIX VII

MAJORITY MEMBERS
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NORMAN SISISKY, VIRGINIA
ESTEBAN EDWARD TORRES, CALIFORNIA
JIM COOPER, TENNESSEE
JAMES R. "JIM" OLIN, VIRGINIA
RICHARD RAY, GEORGIA
CHARLES A. HAYES, ILLINOIS
MATTHEW G. MARTINEZ, CALIFORNIA
TOMMY F. ROBINSON, ARKANSAS

Congreſs of the United States
House of Representatives
COMMITTEE ON SMALL BUSINESS
2361 Rayburn House Office Building
Washington, DC 20515

MINORITY MEMBERS
JOSEPH M. McDADE, PENNSYLVANIA
SILVIO O. CONTE, MASSACHUSETTS
WILLIAM S. BROOMFIELD, MICHIGAN
ANDY IRELAND, FLORIDA
JOHN HILER, INDIANA
VIN WEBER, MINNESOTA
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D. FRENCH SLAUGHTER, JR., VIRGINIA
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J. ALEX McMILLAN, NORTH CAROLINA
JOHN E. GROTBERG, ILLINOIS

MAJOR L. CLARK III, STAFF DIRECTOR
THOMAS G. POWERS, GENERAL COUNSEL
CHRISTINE A. RUSSELL, MINORITY STAFF
DIRECTOR

MAJORITY—225-5821
MINORITY—225-4038

AREA CODE: 202

February 25, 1985

Honorable Doug Walgren
Chairman
Subcommittee on Science Research &
Technology
Committee on Science and Technology
U.S. House of Representatives
2319 Rayburn H.O.B
Washington, D.C. 20515

Dear Doug:

As you are aware, the Department of Commerce has established a small business unit within the Office of Productivity Technology and Innovation (OPTI). The Administration has proposed its elimination. Because OPTI is emerging as a lead agency for innovation policy within the Federal government, it is vital that OPTI maintain a sensitivity to small business and the role small business plays in technological innovation.

Small innovative firms have special needs that are not always recognized or addressed in the programs and policies of the Department of Commerce. A small business office, therefore, performs an important function and should be maintained.

The decline in industrial innovation in the United States has been a matter of considerable concern to the Small Business Committee and prompted me to support the establishment of such an office on the basis that it would serve the Department mission and objectives.

Once again, I respectfully request that consideration be given to the special functions of this small business unit and that funds be authorized for its continuance.

Small firms are the nation's leading innovators but are not always able to marshal the forces necessary to enable them to bring new technologies and processes to commercialization. The existence of a small business office in this important agency can enhance the innovative capacity of small entities, and increase the nation's competitiveness in world markets.

~~In your Committee hearings and deliberations, I would hope that you take the opportunity to ask the Assistant Secretary for Productivity, Technology and Innovation about critical elements of the program and its small business activities and objectives.~~

I sincerely appreciate your consideration of this matter.

Sincerely,

Parren
Parren J. Mitchell
Chairman

PJM:lff

North Carolina State University
School of Engineering

Industrial Extension Service
919 737-2358
Location 215 Page Hall

Mailing Address
Box 7902
Raleigh, NC 27695-7902

March 18, 1985

Representative Don Fuqua, Chairman
Committee on Science & Technology
2321 Rayburn House Office Building
Washington, DC 20515

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

Dear Representative Fuqua:

I was surprised and dismayed to learn recently that the Reagan Administration plans to phase out the Commerce Department's Office of Productivity, Technology and Innovation (OPTI). Although Federal expenditures relative to income must be reduced, the key to real economic prosperity is to increase our productivity in this country. Consequently, the U.S. government needs a strong central office to evaluate our productivity, advocate changes in government that foster productivity improvement, and be a forum and resource for the many industry, local government and cooperative organizations that are making efforts to improve productivity.

Under the able leadership of Assistant Secretary Bruce Merrifield OPTI has provided the only focal point in the Federal government for economic productivity for the last several years. With a small staff it has proven very successful in removing barriers to innovation and stimulating productivity growth. During the past several years OPTI has been especially helpful to us by providing motivation, information, and assistance in helping us to help North Carolina business, industry and local governments to improve their productivity.

As you know, our productivity is equal to our output of quality goods and services divided by our inputs of manpower, machines, materials, technology, etc. In the long run, if we are to have more and better goods and services, we must be more innovative in the utilization of technology and the other input factors.

This is to encourage you to support the strengthening of the U.S. Department of Commerce Office of Productivity and Technology Innovation, not its demise. We need all the help we can get to stimulate and implement measures for improving productivity in this country.

I thank you for your serious consideration of this request.

Sincerely,

TW Stephenson

Thomas W. Stephenson, P.E., Director
Industrial Extension and Applied Research

cc: Representative Tim Valentine

North Carolina State University is North Carolina's original land-grant institution and is a constituent institution of The University of North Carolina

GEORGIA TECH RESEARCH INSTITUTE
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA GEORGIA 30332

GTRI

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

March 12, 1985

Representative Don Fuqua
Chairman, Committee on Science and Technology
2321 Rayburn House Office Building
Washington, DC 20515

Dear Representative Fuqua:

I was surprised to learn recently that the Reagan Administration plans to phase out the Commerce Department's Office of Productivity, Technology and Innovation (OPTI).

Under the able leadership of Assistant Secretary Bruce Merrifield, OPTI has provided the only focal point in the federal government for industrial productivity. With a small staff, it has proven very successful in removing barriers to innovation, stimulating productivity, and thereby assisting U. S. businesses to be globally competitive. Examples of OPTI's accomplishments are:

- Conceived and stimulated the development of RDLPs to finance early-stage innovation. More than $2 billion has become available in this form since 1982.
- Caused modification of antitrust laws to permit industry to collaborate, research, and develop so that U. S. industry can compete in world markets.
- Drafted and obtained approval of a Presidential memorandum that makes contractor ownership of inventions government-wide policy.
- Established a national clearinghouse for writing "best practice" information and techniques for productivity and improvements.

Not only has OPTI been successful in these and other efforts; but as the 1984 study, The Productivity Infrastructure of the United States, pointed out, its continued leadership is needed to "provide an important focus for spearheading the drive for productivity improvement and would make people aware that the government is strongly behind their productivity efforts. Through this office, the federal government could also work to establish a clear, energetic national productivity policy that

Georgia Institute of Technology is an equal education/employment opportunity institution of the University System of Georgia
Georgia Tech Research Institute formerly was the Engineering Experiment Station

would provide a context in which the effort of productivity organizations can find direction and an identity."

I recommend that Congress retain the OPTI in its present form and at the current budget level of $2.4 million. It has proven to be an effective organization which although small has helped bring about some major necessary changes in American productivity and innovation.

Sincerely,

David S. Clifton, Jr., Ph.D.
Director
Economic Development Laboratory

DSC:cw

Howard B. Ellsworth
8428 Cherry Valley Lane
Alexandria, VA 22309

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Honorable Don Fuqua
Chairman, Science and Technology
Committee
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

From the enclosure you can see that I have dedicated my entire career thus far to the military and civilian Federal services. During my civil service assignments at the Pentagon, I was especially active in the introduction and furtherance of the use of the metric system in many aspects of DoD operations. Much of this activity focused understandably in the area of procurement and procurement specifications.

Due mainly to a general misconception by the public, the introduction of metric in this country is unfortunately seen in terms of its social impact rather than its more important national/international economic impact. As virtually the only nation in the world that does not use metric, we are locking ourselves out of important trade opportunities. Also, particularly from my own experience, I know that by not shifting weapons and military systems more rapidly to metric, we are unnecessarily limiting our ability to operate interchangeably and effectively with our metric allies around the world, especially within NATO.

I understand that the Administration's proposed FY 1986 budget calls for the elimination of the Office of Metric Programs in the Department of Commerce. As chairman of the Federal Agencies Metrication Operating Committee and by virtue of my close involvement with metric issues in the Federal Government since the early 70's, I believe that there are too few people who understand fully the importance to the country of this singular little office. It is the only point of focus and the only source of coordination for the Federal accommodation of the voluntary but increasing use of metric in the U.S.

I would be pleased to meet with you or a member of your staff at any time to elaborate on this matter and to assure you through that discussion that preserving a formal office at the Federal level is practical and necessary. We must keep the metric question sufficiently visible to assure that American businesses recognize the needs of the Defense Department and seize international trade opportunities. Both require a continued expansion of metric use and capabilities in our entire commercial/industrial structure.

Sincerely,

Howard Ellsworth

Howard B. Ellsworth

P.S. If you wish to discuss please phone
Enclosures (703) 780-1945
H

TITLE - 50 Word Extract of talk titled "DoD Policy on use of Metric Measurement in Standardization Documents."

Presented before the Standards Engineering Society, Dayton, Ohio, Wednesday, 28 September 1983.

The Department of Defense recognizes that both federal and private sector specifications and standards used to procure newly designed metric materiel must be in place and available for use by our contracting people. This ought to be done early enough to deliver metric dimensioned items in phase with U.S. National and International Defense and Security requirements for such equipment.

Both private and federal specifications and standards management and writing bodies need to join in developing a national metric transition plan.

CLEARED
FOR OPEN PUBLICATION

SEP 13 1983 3

DIRECTORATE FOR FREEDOM OF INFORMATION
AND SECURITY REVIEW (OASD-PA)
DEPARTMENT OF DEFENSE

3515

Title - Status Report on, "DoD Policy - Use of Metric Measurements in Standardization Documents"

By

Howard B. Ellsworth - DoD Standardization
Metrication Transition Policy

Office, Deputy Under Secretary of Defense for
Acquisition Management, Pentagon, Washington, DC 20301

The Department of Defense has recognized that it would be difficult indeed to effect a timely transition to the use of metric dimensioned Military Material in phase with U.S. industrial capability, and to provide such equipment at competitive prices unless we have already on-hand specifications and standards describing our metric dimensioned needs. Further, such documents, which are generally used in Defense procurement contracts should be developed as soon as our engineers have the needed details: form, fit, function, and configuration.

This need is now becoming increasingly apparent. The Defense Industrial Supply Center in Philadelphia has already gone on record that they have had to use NATO standards (DIN) because there is no U.S. Industrial or DoD standards on the metric products they have been asked to purchase. This is adding new items to the Defense inventory and is weakening DoD's Standardization policy to keep the defense supply system as standard as possible and as small as possible.

As many of you already know, Defense has set a goal to have available a spectrum of metric hardware specifications and standards believed to be needed for newly designed defense procurements by the year 1990. I can report to you that because of the implications of the recent OMB bulletin A-119 concerning the use of comercially available standards by federal agencies, Defense is moving firmly, though slowly, in this direction.

In response to President Reagan's 11 April 1983 letter to the American National Metric Council asking both the private and federal sectors to cooperate in achieving Metric transition in the U.S. (copy attached), Dr. Richard DeLauer, Under Secretary of Defense for Research and Engineering, has added his support by requesting all DoD Commands and Defense Agencies to "get-on" with the job of complying with defense transition policies: One of which is that all new designs will use metric dimensions unless it is not in DoD's best interest.

Because 1990 is a DoD effort only, it is necessary that other federal agencies should also have an involvement with the use of metric standards. I am now able to state that at DoD's request and with the General Services Administration's approval, a federal register notice of 20 July 1983 has been published asking for comments to ammend the federal property management regulations to require the use of the metric system of measurement in federal standardization documents. When and if approved by the federal agencies, (the "Interagency Committee on Metric policy" - ICMP) the revision will be published. This action should go a long way toward federal support of the private U.S. sector's American National Metric Council leadership in the development of a national program to address metric transition in the U.S.

In addition, in October 1983 (next month), the 1983 DoD Wide Standardiztion Conference will, as a part of its agenda, also examine DoD's role and activities in the U.S. Metric integration process. The theme of the conference will be "Reducing Acquisition and Support Costs for the DoD."

This brings me to my final thought. Historically, federal Government and specifically the Department of Defense procurement policies discourage meddling in the private market place. Contracting officers are asked to state defense needs as clearly as possible when soliciting bids and or proposals from private industry. It does happen that U.S. manufacturers are not always fully able to design, build and test new complex defense materiel without being provided federal dollars to assist them. Defense Research, development and test funding is used for this purpose. There are also cases when an entirely new technology, such as computer operated machine tools appears, and DoD has (when in our best interest and industry's too) provided assistance in developing a U.S. manufacturing capability. The federal government's Metrication Operating Committee (MOC) and DoD have repeatedly been urged by the private sector's ANMC to require industry to furnish products designed using the metric system as a means of both encouraging U.S. metric transition and fulfulling the basic intent of the U.S. 1975 metric law. The voluntary language of the law and the lack of a firm mandate from the U.S. Congess, has caused the U.S. Metric Transition process to proceed at a pace more or less controlled by the business needs of the private market place and the pressures of international trade.

The President's 1983 letter and the American National Metric Council's (ANMC) 1983 role to provide leadership for the development of a national program (that I referred to earlier) leaves the U.S. Metric integration process pretty much up to our nation's private industry and its standards management and writing bodies. However, I don't believe the federal government's metric focal points would deny support if asked. In a recent discussion with Dr. John Homefeld, of the House Committee on Science and Technology, convinced me that its now time for the ANMC and standards writing bodies to sit down with both Congressional and federal officials and hammer out shared responsibilities in establishing a federal plan. There is no doubt that establishing a national metric market should be one of the major topics to be discussed. Defense would be more than willing to do its our share in a federal agreement. Such an effort would not only enhance the manufacture of new products but would contribute to the goals of the White House Conference on Productivity, established by public law and now curently in session. The sooner the private industrial sector of our country and its closely related standards activities get started on a federal plan, the sooner DoD can add its shoulder to that metric wheel we would all like to start rolling toward a metric America.

We all agree the Metric Conversion Act (P.L. 94-168) is not compulsory legislation. Voluntary Conversion is stressed in its provisions. However, such volunteerism in no way implies a laissey faire reliance on unstructured private initiatives. The act implies the active seeking of a consensus to implement desirable national metric conversion goals for the affected sectors of U.S. Society.

THE WHITE HOUSE
WASHINGTON

April 11, 1983

I am pleased to greet members of the American National Metric Council at your Ninth Annual Conference.

This is the first year the Secretary of Commerce has had the lead Federal responsibility for support of industry's transition to metric measurement. It is gratifying to know that the Department of Commerce is the co-sponsor of the 1983 ANMC Conference.

In the past year, the issue of metric transition has become increasingly important in the area of international trade and productivity. The National Productivity Advisory Committee has recommended that the Federal Government continue to support conversion to metric measurement to enhance U.S. international competitiveness and hence productivity in several industries.

With full cooperation between the public and private sectors, I am confident we can achieve this important goal.

You have my best wishes for a productive and successful meeting.

Ronald Reagan

APPENDIX VIII

FRANK ANNUNZIO, Representative from IL,
Chairman
JOSEPH M. GAYDOS, Representative from PA
ED JONES, Representative from TN
BARBARA F. VUCANOVICH, Representative from NV
PAT ROBERTS, Representative from KS

THOMAS J. KLEIS, Staff Director
ANTHONY J. ZAGAMI, General Counsel
RICHARD OLESZEWSKI, Deputy Staff Director
FAYE M. PADGETT, Assistant Staff Director

Congress of the United States
Joint Committee on Printing

CHARLES McC. MATHIAS, JR., Senator from MD,
Vice Chairman
MARK O. HATFIELD, Senator from OR
WENDELL H. FORD, Senator from KY
CLAIBORNE PELL, Senator from RI

818 Hart Senate Office Bldg
Washington, DC 20510
Phone 224-5241

March 22, 1985

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

The Honorable Don Fuqua
Chairman
House Committee on Science and Technology
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

It has been brought to my attention that the National Technical Information Service (NTIS) has requested changes in its enabling legislation that would permit NTIS to obtain printing services without regard to the Government Printing Office (GPO). I strongly oppose any such change.

The reasons propounded by NTIS to support the request are simply without substance. Those reasons, as offered in Congressional testimony, include "improved control...over scheduling of production, better quality control, and lower costs." Please allow me to address each point in turn.

The criticism of the printer for scheduling difficulties and failure to meet delivery dates is prevalent throughout all of publishing. While the printer is occasionally at fault, far more frequently the printer is simply the scapegoat for bad planning, preparation and scheduling. In those rare circumstances where exigencies demand a quick response to a printing requirement, the Government Printing Office is well-equipped, through a variety of mechanisms, to produce or procure whatever is required.

Likewise, since NTIS and GPO each would have to rely upon a commercial contractor, it is difficult to imagine a reason why an NTIS contractor would produce greater quality than a GPO contractor. GPO can procure any level of quality that is desired.

Finally, it is equally hard to imagine how NTIS could acquire their products at lower prices than are available through GPO. The GPO has a list of potential contractors that exceeds 8,000 names. Competition for work is extremely strong. NTIS procurements are not likely to be exposed to such competition. In addition, NTIS procurements would require the dedication of appropriate NTIS staff time to contract writing, contract administration and contract dispute resolutions. These things are all available through GPO for a minimal administrative charge. For NTIS to duplicate these functions would be patently wasteful. To illustrate this point, in 1984, NTIS was billed 768 times by GPO for separate printing orders that in total cost slightly less than $1.2 million. To process and administer that number of orders, GPO charged NTIS approximately $59,000, or about 5 percent of the total billing. It is highly unlikely that NTIS could have performed all of the contracting functions themselves for $59,000. Therefore, allowing NTIS to obtain printing on its own will likely result in higher costs overall.

The Federal printing program, with GPO at its center, was established to take advantage of principles of centralization and economies of scale. GPO personnel are trained specialists at the functions they perform. They administer a highly competitive system in which the overwhelming majority of competitors are small businesses. To begin the fragementation of such a proven system simply to accommodate an agency's ill-founded assertions or suppositions would be detrimental to efficient government administration.

I strongly urge you and the other Members of your Committee to reject the change requested by NTIS.

With every best wish, I am

Sincerely,

Frank

Frank Annunzio
Chairman

Appendix VIII.

Questions and Answers for the Record

A. John Gosden

B. National Bureau of Standards

C. OPTI and NTIS

THE EQUITABLE LIFE ASSURANCE SOCIETY OF THE UNITED STATES
1285 Avenue of the Americas, New York, N.Y. 10019

JOHN GOSDEN
Vice President

March 25, 1985

Messrs. D. Walgren, M. Lujan
Committee on Science & Technology
U.S. House of Representatives
Washington, D.C. 20515

Gentlemen:

I enclose my reply to the questions you sent me in your letter of March 7, 1985, related to my testimony on the budget and plans for The Institute for Computer Science at NBS.

Sincerely,

REMARKS ON PRIVATIZATION OF ICST NETWORKING PROGRAM:

As I indicated in my testimony, ICST has demonstrated that it is uniquely situated and qualified to be an effective, impartial negotiator among vendors, users, and representatives of other countries. It is an important national resource, not just in computer networking, but across all areas addressed by its program. I do not believe it would be wise to attempt to move part or all of the ICST program to the private sector for the following reasons:

(1) The necessary environment does not exist. U.S. industry has a difficult enough time cooperating in the development of standards in the national arena, where they are competing with each other. In my opinion, it is not realistic to expect U.S. companies to effectively cooperate in the development of international standards, while protecting proprietary data from each other.

(2) I see no evidence of long-term, broadly-based financial support for this effort by industry. Industry is indeed interested in the development of tests for emerging networking standards. This is a short-term activity, however, and does not automatically imply industry's long-term commitment to funding the early research and development necessary for future standards in this or other critical areas, such as software and hardware interfaces.

(3) The proposal to privatize the networking program does not address other critical standards areas. ICST is currently leading national and international standards efforts in software, computer security, and hardware interfaces. In the software area alone, U.S. industry held over 70% of the $18 billion world-wide software market in 1983. Software is the only high-tech industry which has not yet seen U.S. world leadership eroded by foreign competition. Abandoning ICST's program in such areas at this time, in favor of focusing only on its networking role, would be unwise.

(4) The proposal does not address Federal standards requirements. As you know, the Brooks Act directs the Department of Commerce to develop Federal information technology standards. As I stated in my testimony, if such central help to agencies is eliminated, it will spring up in multitudinous places at greater expense and with less effectiveness. An expenditure of $10 million to more effectively utilize $14 billion in Federal information technology expenditures is money well spent.

(5) Critical time would be lost. Even if, over the course of many years, an effort to privatize some or all of the functions of ICST were to be successful, much time would be lost in the

attempt. With information technology moving so rapidly, and ICST already recognized as an effective player in the field, how can we justify an experiment such as privatization?

I feel that there is some merit to its objectives which recognize the importance of international standards and test methods and the attempt to increase industry involvement and stabilize funding for these activities. The program as currently carried out by ICST emphasizes the importance of international networking standards and of developing test methods for standards.

ICST has demonstrated that it can work effectively with and on behalf of U.S. industry, and has available to it mechanisms for increasing the involvement of industry in all areas of its program. Rather than taking the high-risk approach of attempting to privatize a part of ICST's program, I would encourage the Congress to seek a mechanism to formally recognize ICST's international standards role in support of U.S. industry, and to increase the resources available to perform this role. With increased resources and stable Federal funding, ICST will be better able to build increased cooperative efforts with industry.

RESPONSES TO QUESTIONS ON PRIVATIZATION:

1. Would the U.S. role in developing international networking standards be weakened if the research, on which the U.S. position is based, was developed by users, or alternatively by vendors?

ICST has been the principal representative of users in the national and international standards development arena for the last 20 years. Other users have been unable or unwilling to commit long-term resources and highly technical professionals to the development of standards. Vendors participate in standards development, but must be concerned with preservation of their market shares. To expect either users or vendors to effectively develop international standards is not realistic. ICST effectively works with both groups in developing technical positions and advancing standards that serve both users and vendors. I see no reason to change a mechanism that works well.

2. If the program is transferred to the private sector, what residual role would remain for the NBS?

If the Congress approves the Administration's requested budget reduction for ICST, then ICST will for all intents and purposes be forced to cease operations. The transfer of any part of the remaining program to the private sector under those conditions would only hasten ICST's total demise.

If the Congress chooses to again restore the proposed budget reduction, and the $2.7 million in annual funds currently being spent in the ICST networking program were to be transferred to the private sector, ICST would still drop to below critical mass and would be unable to protect itself from dying.

By moving the funds associated with networking out of ICST, those funds would no longer be available for the new areas of work that would normally be addressed as the networking program matures and moves to a maintenance level of operation.

3. If the vendors perform the standards work, is that work likely to be dominated by one or two companies? Would it adequately reflect the needs of the users?

As I stated earlier, I do not believe that a climate exists for vendors to perform the standards work without participation of an impartial, third party such as ICST.

4. What level of funding would be required of the federal government over the next several years to maintain a first-class networking program in NBS? Is it reasonable to ask NBS to secure

additional industry support in this area? Through what trade associations would such support be channelled?

Funding for networking activities has been stable or slightly increased since FY1979. This is inspite of the overall ICST budget reduction of 15% in FY1983. In FY1984 the networking program was funded at approximately $2.5 million. Funding was increased to nearly $2.7 million in FY1985.

In its budget submission for FY1979, the OMB requested $17.9 million in total funding for ICST. That level of funding would have permitted ICST to develop a comprehensive program of needed standards and guidelines across the high priority areas (including networking) identified in its five-year plan. Congress approved a budget of $11.3 million for that year. ICST's funding was reduced to $10 million in FY1983 and has remained constant at that level.

ICST developed an effective program of work at the $11.3 million level of funding appropriated in FY1979. An equivalent funding level, in current dollars, would seem appropriate for ICST.

Perhaps equally as important as level of funding is stability of funding. ICST will be better able to build cooperative, long term projects with industry if its budget is not in jeopardy every year. Obvious associations for increased collaboration include CBEMA, CCIA, the Computer Security Institute, ADAPSO, ABA, National Computer Graphics Association and ASME. ICST already works with these and other associations.

5. What preparations should be made for a transfer to the private sector? How fast could it occur?

I believe that I have addressed this question in my remarks on privatization.

RESPONSE TO MINORITY QUESTIONS:

1. You have talked about expected benefits. When were these studies done? Has there been any follow-up studies showing actual costs and benefits? What ICST products were involved?

The referenced cost-benefit studies have been performed by ICST contractors between FY1979 and the present. I'm sure that copies can be obtained from ICST.

As you know, it is difficult at best to identify actual cost savings within the government. Often savings are realized through cost avoidance or improved effectiveness. As I stated in testimony, ICST has published many standards and quidelines and these are widely used. The quality and value of this work is evidenced by the extent to which private industry uses these products. Organizations such as my own accept as a principle the concept that technically sound standards produce economic benefits. That is why we support corporate standards programs.

However, I am aware of one follow up study which examined the savings achieved from the COBOL programming language standard at one major, federal installation. While it would be desirable to document the savings that standards produce, such studies can be quite expensive, and are generally regarded to be of limited value, especially when they deflect already limited funds from critical standards development efforts. (A copy of that study should be available from ICST.)

2. ICST received its full funding only 5 years ago. Before that, how were you operating? How have you managed to be a leader for the past 20 years? What resources are you putting into languages now?

Beginning in the early sixties, NBS was involved in the development of a limited number of efforts such as the programming languages COBOL and Fortran and the standardization of the ASCII character set for information interchange. The major portion of the funding received in FY1979 went into new areas such as networking, software engineering, and database technology.

Today, most of the work in programming language standardization has moved into a maintenance phase and attention has been directed to higher level languages and software facilities for achieving increased productivity in applications development. For FY1985, ICST's work in the broadened area of computer software is approximately $1.4 million.

3. You commented that "ICST has already begun to produce guidance on selecting and managing micros, aimed at Federal users." How does this function differ from what GSA does?

I am not personally familiar with activities of the GSA in this particular area. However, ICST efforts in the microcomputer area are primarily technology-based, relying heavily on laboratory activities, and include standards development efforts for flexible disks, data interchange, computer graphics, operating systems, and microcomputer interconnection.

ADDITIONAL QUESTIONS ON PRIVATIZATION

1. It would seem that both the user industries and the computer manufacturers have tremendous stakes in ICST's network program. Have you explored the possibility of some of them supporting this activity within the private sector?

This question has been addressed under my response to privatization.

2. My understanding is that ICST's interest in the networking area springs from its responsibility to ensure that the federal government have access to efficient computing resources. That interest is identical with that of other large computer users. Would it be possible for ICST and other large users to join forces and support a larger effort in this area outside of the federal government?

This question has been addressed under my response to privatization.

3. With the technology moving as fast as it has, can the federal government assemble resources quickly enough to keep up with it given the regulations governing hiring and contracting? Particularly with the budget uncertainties, it is hard to see how you can hire and keep the "new blood" that this field demands.

The way you deal with these problems is by retaining a core of staff with broad experience and technical expertise, and by supplementing this core with the narrow skills of contractors, where necessary. ICST is indeed faced with many obstacles as it attempts to perform its mandated activities. The success it has achieved in building and maintaining a sound program despite budget uncertainties and administrative restrictions is largely due to the competence and dedication of ICST management.

APPENDIX IX

Questions for Dr. Ambler
NBS FY 1986 Authorization
February 26, 1985

REDUCTION IN GRADES GS-11 THROUGH GS-15

QUESTION 3: In the President's Deficit Reduction proposal, NBS will face a reduction in GS-11 through GS-15 personnel of two percent per year for five years. How will this affect NBS's ability to attract top scientists? Is this reduction in the absolute number of positions at NBS or is it a reduction of senior manpower as a percentage of total staff?

ANSWER: These restrictions are making it more difficult for NBS to attract and retain new scientists. NBS, however, has not had to reduce its total number of positions as a result of this proposed Administration reduction.

QUESTION 4: How would you staff your proposed new initiatives if they are approved? Don't starting scientists in biotechnology, process technology, and materials science expect salaries at least at GS-11 and also expect to be promoted in fairly short order? If you hired a professional at GS-9 or below, would he not expect to be promoted to at least a GS-11? Do researchers in biotechnology demand higher salaries than building researchers or fire researchers with similar experience?

ANSWER: To date, the reductions have been applied only to base programs. The normal entry level for an individual with a master's degree is GS-9, with a Ph.D. a GS-11 or 12. Professional staff who are hired at entry levels do have an expectation that they will be promoted to the next higher level. Research scientists and engineers generally command comparable levels where experience and expertise normally determine the GS level at entry. A "researcher" in either of these three programmatic areas might be a chemist or chemical engineer, for example.

QUESTION 5: Has NBS started to implement this reduction in GS-11s through GS-15s? Are other government R&D laboratories facing the same reduction in GS-11 through GS-15 that NBS is?

ANSWER: NBS is implementing this reduction through controlled replacement of 2/3 of the vacancies in this grade range from attrition. The remaining 1/3 will not be filled at the GS 11-15 level. It is our understanding that all agencies have been directed to reduce the number of GS 11-15 jobs.

Questions for Dr. Ambler

FACILITIES

QUESTION 10: The recent GAO report on NBS facilities stated that precise costs of operating NBS facilities are not available. How do you determine what to charge those who wish to use an NBS facility for proprietary research?

ANSWER: The fees for using NBS facilities for proprietary research are based on full cost-recovery of the associated marginal costs. The factors that are included in the fee calculation are based on the amount of NBS labor, if required, special supplies, services, and utility costs. These costs are determined by the manager of each facility based upon the nature and extent of the proprietary research.

QUESTION 11: GAO also noted a "lack of documented analysis or plans of NBS facilities needs and alternatives considered for meeting these needs." Is this a fair criticism? Would there be any merit in NBS developing operating plans for its facilities? Should NBS look elsewhere to determine if a similar facility exists before committing to build a facility?

ANSWER: The GAO report contains as an appendix a copy of a letter from NBS Director Ernest Ambler to J. Dexter Peach, Director of Resources, Community, and Economic Development Division of GAO. That letter expresses NBS concerns regarding many of the conclusions and recommendations of the GAO report.

The GAO conclusions regarding the NBS planning process are unfounded. Decisions on acquisition and elimination of facilities are based on priorities within programs and the overall priority of the program. Participants in the programmatic planning and review process include Congress, the Statutory Visiting Committee, the Boards of Assessment and industry and university contacts. Plans and funding of new and existing research programs consider the needs and costs of the required research facilities as part of the overall programmatic review process, rather than a separate activity. Research facilities are established and maintained because of their criticality to supporting the NBS mission; frequency of use is of secondary importance.

NBS does look elsewhere to determine if a similar facility exists before committing to build a facility. The existence of a similar facility elsewhere does not necessarily imply that NBS should not also have such a facility. Other factors such as availability, suitability, and overall cost must be considered. The GAO statements that NBS failed to consider alternatives to the NBS Tri-directional Structural Test Facility are incorrect. Alternatives at the University of Texas facility were considered and rejected as inadequate to meet NBS program responsibilities. The facility at NASA's Marshall Space Flight Center was not a viable alternative. The NASA facility is a shake table with which forces can be applied only to the base of a specimen. It does not offer the type of testing capabilities available at the NBS facility.

Questions for Dr. Ambler

FACILITIES

QUESTION 12: Do budget limitations or personnel ceilings limit the extent to which NBS can offer facilities for outside research?

ANSWER: Budget limitations or personnel ceilings do not limit the extent to which NBS facilities are available for collaborative research. Proprietary research at NBS facilities is not affected because the fees charged to the users recover marginal costs.

QUESTION 13: How do you answer GAO's conclusion that the computer industry has provided neither funds nor equipment to NBS's fabrication facility? Should they?

ANSWER: The primary purpose of the research performed at the Superconductive Circuit Fabrication Facility is to provide new measurement techniques and standards for high speed and high accuracy electrical measurements in support of NBS' traditional role of providing measurements and test methods. Collaborative work in this facility between NBS, industry, and other federal agencies occurs when the research is of mutual interest. Appropriate cost-sharing arrangements are then established. The computer industry has not provided funds nor equipment to this facility even though the facility has been in existence since early 1970. The defense aerospace contractors that manufacture electronic equipment, such as Westinghouse and Hughes Aircraft, have sent Research Associates to work at this facility. Although these people are funded by the sponsors and represent a contribution, we intend to encourage direct support from industry. In addition, the Navy has provided substantial funds and equipment in support of the facility and its research. Other collaborations and support are anticipated as the research develops.

QUESTION 14: Why doesn't NBS routinely collect data on the use of all its facilities?

ANSWER: There is little to be gained by keeping detailed records of facility use since it is the research results or the calibrations obtained through use of the facility that are of value. The research results are carefully monitored and evaluated on a regular basis. Requirements for routine recording and reporting on facility use are more appropriate for production operations than research laboratories. Such data are collected for those facilities where usage data are needed for planning and scheduling.

The facilities at NBS are the tools with which NBS scientists and engineers conduct their research. Facilities are established, maintained, and used because of their importance to supporting the NBS mission and accomplishing programmatic objectives.

Questions for Dr. Ambler

EQUIPMENT

QUESTION 15: How does the equipment decrease of $3,265,000 through the working capital fund effect NBS programs? When will it be felt? Is this a one-time decrease or can we expect a de-emphasis on equipment at NBS once again?

ANSWER: The decrease will have a minimal program impact in FY 1986. Congressional acceptance of either of the NBS proposed authorization and/or appropriation language changes will allow NBS to retain fees on current replacement value of the equipment. This accounting change will reduce appropriation requirements by enabling NBS sponsors to help finance the equipment replacement augmentation costs. The budget proposals are not an attempt to de-emphasize equipment at NBS, but reflect a need to change the method of financing equipment augmentation and promptly returning NBS to the present level of equipment funding.

OUTSIDE FUNDING

QUESTION 17: The Bureau has done a commendable job of attracting agency funding and industrial in-kind support which in FY 1986 may supply more than one half of the NBS funding. Is there an outside limit on the amount of funding and manpower you will accept from sources other than Direct Appropriations? Do you worry about whether outside entities may begin to dictate NBS priorities because of their control of the purse strings?

ANSWER: There are limits on the amount of outside funding that NBS will accept:

A. Other government agency funding is limited in three ways; namely, (1) it must meet the NBS criteria for such work (copy attached), (2) NBS must have qualified staff on board to perform the work or sufficient FTE ceiling to add additional staff, and (3) the necessary facilities and equipment or funds provided by the sponsor to acquire them.

B. The work to be carried out with industrial in-kind support must either contribute to a collaborative effort on a current NBS program, enhance NBS' ability to transfer the results of its work, or enable academia and the private sector to make use of unique NBS facilities. The total amount is also limited by available laboratory and office space, equipment, and time on NBS facilities.

As a result of these limitations, NBS does not anticipate having its priorities dictated by outside sources of support.

8.05.07

CRITERIA FOR NBS ACCEPTANCE OF OTHER-AGENCY WORK

a. Any proposed other-agency work must meet at least one of the following criteria before NBS can accept the work:

(1) Acceptance by NBS establishes traceability of measurements to national standards.

This criterion is intended to cover other agency work which relates to the basic or "core" responsibility as stated in 15 U.S.C. 272(a) of the NBS organic act of March 3, 1901, as amended. Under this Section, NBS is authorized to undertake "The custody, maintenance, and development of the national standards of measurement, and the provision of means and methods for making measurements consistent with those standards, including the comparison of standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the Government."

(2) Private sector cannot or will not develop test methods for materials, mechanisms, and structures related to items purchased by the Government or important to the public interest.

This criterion is intended to cover NBS authorizations as stated in 15 U.S.C. 272(c) and (d) of the NBS organic act. Included are "...development of methods for testing materials, mechanisms, and structures, and the testing of materials, supplies, and equipment, including items purchased for use of Government departments and independent establishments" and "Cooperation with other Governmental agencies and with private organizations in the establishment of standard practices, incorporated in codes and specifications." NBS accepts other-agency work within this criterion under a number of conditions, including:

(a) Situations where private sector interests cannot reach a consensus due to divergence of practice or tradition or are unable to undertake a research program because of the fragmented nature of the industry;

(b) Voluntary consensus system cannot react to needs in an acceptable time frame;

(c) Possible conflict of interest requires NBS presence and/or participation for equity; and

(d) Comprehensive NBS capability required for solution.

(3) Support services to other agencies authorized or mandated by specific legislation, for example:

—Federal Property and Administrative Services Act of 1949 (Brooks Act)
—Radiation Control for Health and Safety Act of 1968
—Consumer Product Safety Act
—Solid Waste Disposal Act
—Earthquake Hazards Reduction Act
—National Climate Program Act
—Trade Agreements Act of 1979

This criterion is intended to cover work accepted by NBS through specific legislative channels outside of the NBS organic act (15 U.S.C. 271 et. seq.). Those having greatest weight are Public Laws directing NBS, either directly or through delegations from the Secretary of Commerce, to support mission agencies.

Interagency agreements are considered supportive under this criterion as are Executive Orders, Presidential Commission Citations, GAO Reports to the Congress, and similar evidence of recognition of the NBS role.

(4) A contract placed outside the Federal Government would result in an unavoidable conflict of interest.

This criterion covers work accepted by NBS where use of a private sector source would threaten credibility because of a conflict of interest. Much of the work performed for regulatory agencies falls under this category because available private sources also work for organizations which would be regulated by test methods and criteria established under the other-agency orders. Other activities having wide impact on the general public involving sampling for regulatory control, randomization of a selective process (e.g., Selective Service), and certain types of IRS processing activities are included.

(5) Requirements for accuracy of physical constants and properties of materials cannot be met by other sources.

This criterion is intended to cover other-agency work as stated in 15 U.S.C. 272(b) of the NBS organic act. This Section authorizes NBS to determine "...physical constants and properties of materials when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere."

In using this criterion as the sole basis for accepting other agency work, the program manager should be satisfied that a private sector source is unavailable to meet the accuracy conditions which the requesting agency can tolerate in carrying out its mission. A statement from the other agency may satisfy this requirement if the program manager does not have knowledge to the contrary.

(6) Unique capability of NBS required for support services to other agency.

This criterion is intended to cover other-agency work which requires a unique capability in the form of staff expertise, equipment, facility (e.g., reactor, linac), or a combination of these, which exists at NBS. It cannot be used to justify work for which legal authority is lacking or work in competition with the private sector.

(7) Use of a private sector source by the other agency would cause significant and intolerable delays in providing services and results.

This criterion covers other-agency work where there is a clear advantage to the Government in timeliness to have other agency work done at NBS rather than in the private sector. The case for acceptance under this criterion must be made in writing by the other agency.

(8) Use of a private sector source by the other agency would result in a higher cost to the Government.

This criterion covers other-agency work where there is a clear and significant advantage to the Government in cost to have other-agency work done at NBS rather than in the private sector; generally, work will not be accepted from an other agency solely because it will be less costly to the sponsor. In the rare cases where it is felt that NBS should accept other-agency work with this criterion as the only one, specific approval must be obtained in advance from the Director supported by a comparative cost analysis prepared by the Budget Office.

b. In addition, the following checklist contains questions which must be considered in deciding whether the technical staff recommends Bureau acceptance of the other-agency work.

(1) Can NBS fulfill a critical need of the other agency?

(2) Will the work supplement and foster NBS STRS programs and missions?

(3) Is the other agency willing to carry its share of funding including the support of research required for performance of the service?

(4) Will there be joint planning by the other agency and NBS to develop relevant tasks of predictable duration and, in some cases, sustained programs with well-balanced exploratory and applied research along with services?

(5) Will public releases be made jointly by the other agency and NBS?

(6) Are the tasks of a "job shop" or routine testing nature or do they involve over-investment of accompanying STRS funds and equipment? Such tasks should be taken only in cases of emergency and where NBS has unique capabilities, responsibilities, and obligations.

(7) Does NBS have adequate staff, relevant experience, and equipment to at least nucleate programs? Are there other reasons to expect effective working relations with other organizations such as standardizing bodies, evaluation panels, or interest groups which may become involved in the program direction and implementation?

(8) Is the work classified? If so, are there significant advantages for NBS that offset the disadvantages associated with classified work? (See Section 8.05.16.)

(9) Is there or can there be established a clear assignment of management responsibility within NBS and specific provision for quality control and output evaluation within NBS?

(10) If NBS performs well, will the problem be solved? For example, good physical measurements or analyses are usually only a part of the problem. Are the other aspects of the problem being adequately considered?

(11) Is NBS willing to continue the work long enough to satisfy the other agency's original requirements? There must be joint commitment.

8.05.08
INFORMAL NEGOTIATIONS

Although in many instances a formal proposal is required, the technical staff members may find it desirable to conduct informal negotiations with representatives of the sponsor. These informal negotiations may be followed by a formal proposal, or in some cases may result in receipt of an order without a formal proposal. The Bureau cannot be officially committed by informal negotiations.

8.05.09
FINANCING GUIDELINES

a. Care should be taken in the development of resource estimates to ensure that all appropriate costs are included. Prospective sponsors not familiar with the statutory authority and financial system of the Bureau must be informed at an early point in discussions that the Bureau is authorized to charge for the full cost of services provided, including all overheads or indirect charges, and that the normal practice of the Bureau is to require an advance of funds for other-agency projects, although reimbursable work may be arranged. Large reimbursable orders create Working Capital Fund cash problems and should not be entered into without early consultation with the Office of the Comptroller.

b. Authority to waive charges for a sponsor under certain circumstances rests with the Director. However, the decision not to charge a bona fide cost to a sponsor does not eliminate that cost from the NBS accounting system. All waived charges must be accounted for, and any charges waived must be recovered by transferring the costs to the appropriate STRS cost center (see Appendix G on waiver of overhead charges to sponsors).

Questions for Dr. Ambler

DISCONTINUED PROGRAMS

QUESTION 18: In what ways over the past three years has the NBS prepared for private sector and/or state and local government takeover of the fire and buildings programs? Have you identified likely candidates from within these sectors to carry out this work? Does NBS have funds available to provide for an orderly transition should the Congress go along with these requests?

ANSWER: We have informed organizations such as trade associations, NIBS, NCSBCS, U.S. Chamber of Commerce, National Fire Protection Association, and Factory Mutual Research Corporation, as well as organizations represented on the CBT and CFR Boards of Assessment. It would be the province of the industry working with the appropriate state and local governments to determine likely candidates for future work. NBS has funds available for the orderly close-out of the current programs.

QUESTION 19: What will become of the unique facilities currently dedicated to these programs? Would the private and public sector successors to NBS's fire, building and computer programs be able to use or to run these laboratories and facilities?

ANSWER: Facilities will be available for use by anyone meeting the criteria for the use of NBS facilities and willing to pay the full operating costs.

Questions for Dr. Schwartz
NBS FY 1986 Authorization
February 26, 1985

CENTER FORMATION

QUESTION 1: We understand that the intent of establishing the Center for Materials Science was to give more emphasis and visibility to the important standards work now required by the rapidly advancing improvements in advanced materials. In your opinion, if we are to meet the Japanese challenge, what should your center include five years from now? What would a fully developed materials program for NBS include?

ANSWER: Materials Science and Engineering is a dynamic field, changing in scope as new technologies emerge. The Center for Materials Science should include expertise in those areas critical to the establishment of important standards in these new areas. In addition, the Center must maintain its efforts in support of existing technologies lest they become increasingly noncompetitive in the world market. These efforts include development of sensors for the steel industry, evaluation of ceramic phase diagrams, study of failure mechanisms in polymers, and a host of other programs associated with processing, structure, properties and performance of materials.

Questions for Dr. Schwartz

CENTER FORMATION

QUESTION 2: What staffing requirements do you expect to have over the next few years? How long do you expect it to take before NBS' program will be world class?

ANSWER: The Center for Materials Science is already world class in many of the fields. Advancement to world class efforts in those areas delineated in the answer to question 1 will depend on the funding schedule. Immediate staffing requirements are 31 FTE to be added over the period as the Cold Neutron Facility comes on-line and 28 FTE to be added as the Advanced Ceramics program is implemented.

ENGINEERING DATA

QUESTION 1: How does the United States compare with Japan and Europe in the evaluation of engineering data in the materials field?

ANSWER: There are notable efforts in the compilation and dissemination of evaluated materials engineering data in both Europe and Japan which compare favorably with efforts in the United States. There is increasing support for evaluated engineering data abroad which in some areas now provides trade advantages to foreign industries. Within the United States there is considerable awareness of the need for evaluated data as witness the new joint industry-professional society-NBS efforts in phase diagrams, corrosion data, and the intellectual linkages of computerized data bases.

NBS provides strong leadership in international efforts to coordinate data evaluation and to standardize data base nomenclature. This includes activities in materials property data under the auspices of CODATA - the international committee for scientific and technical data; chemical data base efforts of the International Union of Pure and Applied Chemistry; and international workshops leading toward a computer accessible materials data system. These and many other international activities by NBS will greatly expand the leverage of U.S. efforts and will increase the availability of foreign data to U.S. industry.

Questions for Dr. Schwartz

STEEL PROGRAM

QUESTION 1: What is the effect on this program of the $2.5 million request being turned down by OMB? What would NBS' role be in the movement of the sensor technology from laboratory scale to plant application?

ANSWER: In order to respond to the requested Steel Industry/Federal Laboratories (SI/FL) program participation NBS requested an additional $2.5 million to its FY 1986 budget allocation for on-line sensors, predictive modeling, and chemical data. This is about $1 million more than the industry was willing to contribute. NBS currently allocates about $1 million annually to steel-related research which will continue.

During the research and development stage of the proposed SI/FL program, the Federal Laboratories would assume the majority of the fiscal and technical responsibility of the program. The steel industry would provide funds for steel industry personnel to be assigned to the Federal Laboratories for the purpose of consultation and codevelopment of technology. At the point the technology is to be moved to the mill, the respective roles of the Federal Laboratories and the steel industry reverse, and the majority of the responsibility (both fiscal and technical) will be assumed by the industry. It is anticipated the Federal Laboratories would continue to be involved through consultation and follow-up laboratory research if indicated by operational experiences.

QUESTION 2: What will it cost to move this technology from the laboratory to the steel mill and to what extent is the steel industry willing to pick up that cost?

ANSWER: The cost of implementing any new technology is usually considered to be at least several times that of research and development. It is not clear to what extent the steel industry is willing to pick up this cost.

Questions for Dr. Schwartz

STEEL PROGRAM

QUESTION 3: Are there other steel technologies such as direct casting of flat rolled products where NBS standards expertise can be useful in a cooperative venture?

ANSWER: Certainly, but the SI/FL steering committee determined that the three identified areas (on-line sensors, predictive modeling and chemical data) were of top priority for NBS participation.

COLD NEUTRON RESEARCH FACILITY

QUESTION 2: Why is such an expensive building needed? If you receive $4 million instead of $8 million would it be useful? What is the total estimated cost of the building and what would you do with half the total estimated cost?

ANSWER: The cost of the proposed cold neutron facility is dictated by the large size building required to house 15 experimental stations and the special characteristics and systems needed to support these stations. For example:

o The entire building must be supported on pilings driven to bedrock and 2000 lbs/square-foot floor loadings must be provided because of the extreme stability required by the guide tube assemblies and the very heavy experimental stations.

o The building must be 25 feet high and be serviced by a 20 ton overhead crane to allow assembly and modification of the experimental stations and associated massive shielding.

o A number of other special systems must be included, e.g., for the distribution of cryogenic fluids throughout the experimental hall and extensive and complex electrical service.

Given Federal procurement regulations and cost effective phasing of the construction, $8 million is the minimal amount necessary in FY 86 to build the facility that we propose.

Downsizing the facility consistent with a $4 million investment the first year and a total cost of perhaps $15 million would result in an experimental hall able to accommodate only seven experimental stations. So few stations would not fill a number of clearly identified national needs for cold-neutron measurement technology. By comparison, the two major centers in Western Europe each have in place or under development more than 15 cold-neutron instruments and the recently funded Japanese facility will include a comparable number of stations.

Questions for Dr. Schwartz

ADVANCED CERAMICS

QUESTION 1: Why cannot universities perform the role described here for NBS?

ANSWER: The proposed program in Advanced Ceramics will lead to the development of standard reference materials and evaluated materials property data, roles uniquely performed by NBS. The main roles of universities are basic research and education. Because of the different roles, the breadth of expertise and facilities within CMS is rare or nonexistent at a university materials science department.

The NBS program will be coordinated with industry, other government agencies and universities. It is a critical component in a nationwide effort, not a substitute for the efforts of others.

Questions for Mr. Burrows
NBS FY 1986 Authorization
February 26, 1985

ICST

QUESTION 1: Since the pace of computer technology is accelerating rather than slowing down, how will your organization keep up to the extent necessary to deal internationally in standards activities on half the budget you now have? Do you worry that if your employees are not engaged at least part-time in state-of-the-art research that they might lose interest and not stay current?

ANSWER: Given the President's proposal ICST will cover only networking in the international arena. Other activities will be dropped or phased out as required by reduction in funds. It is expected that expertise in networking will stay current since state-of-the-art research will be maintained in that area.

QUESTION 2: To whom will the voluntary standards organizations turn to for the data to back up their work if NBS is no longer involved?

ANSWER: Private industry, including users and vendors.

QUESTION 3: Does NBS' withdrawal from national standards work mean that NBS employees will not be available to help on domestic standards committees where they now play such a major role?

ANSWER: That is correct.

QUESTION 5: Which programs currently in existence will be cut back or eliminated in an ICST budget of $5.0 million? Will the computer security efforts continue?

ANSWER: The loss of $5M will confine ICST's activities to a reduced program in the area of international networking standards. All other work will be terminated. Specifically, we will no longer work in areas connected with the management and use of computers. This area includes computer security, data base management, end-user applications, programming languages, software development and maintenance, and selection and management of computers. Research on storage technology will also be eliminated and new developmental work in the network program will progress at a slower pace. All supporting laboratory efforts for these eliminated areas will be terminated. Given the pace of computer technology and the value of these areas to the industry, we anticipate increased voluntary standards development by the industry.

Questions for Mr. Burrows

ICST

QUESTION 6: Are you experiencing a higher rate of turnover in ICST than you did when the program was not under attack?

ANSWER: The turnover rate in FY 1979, prior to proposals of program reductions, was approximately 7%. It has varied from approximately 5% to approximately 19% over the period from FY 1980 to FY 1984, averaging approximately 12% without apparent pattern. Despite the fact that reductions in the ICST program have been formally proposed for four consecutive years, ICST staff members are very dedicated to their work and ICST has been able to attract excellent new personnel to our program. Of course, the training and work undertaken by our personnel makes them very attractive to industry as well.

QUESTION 8: What impact will the cutback have on ICST's growing reimbursable program?

ANSWER: Historically, reimbursable projects have been attracted on the basis of in-house expertise, generated largely by direct Federal funding. Thus, reimbursable funding can be expected to dry up in those areas where direct Federal funding is eliminated.

Questions for Dr. Johnson
NBS FY 1986 Authorization
February 26, 1985

BIOTECHNOLOGY

QUESTION 1: You have requested $3,000,000 to develop a measurement base to advance the commercialization of biotechnology in chemical production and related industries. Is it possible to carry out such an effort with this level of resources or is this just the first step towards building up a biotechnology capability? What do you expect the ultimate size of this program to be in dollars and manpower?

ANSWER: The budget request of $3 million is the minimum amount necessary to develop the measurement methods which NBS needs to provide the required services, reference materials and data to support industrial applications of biotechnology.

With this level of funding NBS can provide: information on the properties and chemical activity of biomolecules, specialized measurement capability, reference materials, predictive models, and broad generic data bases. The level of funding is set on the basis of number and types of expertise needed to provide the services determined from the overall plan.

We expect to employ 28 scientists who will build NBS basic services capability. Within three years, NBS expects to provide a broad range of biotechnology related measurement services which will produce a reimbursable income of approximately $1.5M/year. With the addition of this reimbursable money, NBS expects to employ approximately 45 scientists in this area. This is the final size of the program that we plan.

Questions for Dr. Johnson

BIOTECHNOLOGY

QUESTION 2: How big a biotechnology program do you now have? What kind of experience do you have in attracting the people you want? Why would a brilliant biotechnologist want to work on establishing standards when he could be making a killing building up a small company or working for one of the major companies entering the field? What is the average age and qualifications of the people you have been able to attract to date?

ANSWER: Our efforts in biotechnology are presently based on a very limited investment to build basic expertise. We are spending about $800K/year in biotechnology related research under our competence building program.

Preliminary indications - inquiries, referrals, recruitment, scientists seeking collaboration - make clear that NBS will be able to attract the people it needs in biotechnology.

Strictly speaking, NBS is not seeking to hire specialized biological experts such as gene splicers, but rather physical scientists with biological interests who wish to apply their expertise to measurement problems in biotechnology. NBS expects that its reputation for being at the forefront of measurement science in many areas will assist in attracting talented scientists to join the NBS biotechnology effort.

To date, inquiries and hires have averaged early 30's in age, several years of postdoctoral experience, research backgrounds at bio-physical science interface.

QUESTION 5: Won't the FDA and other regulatory agencies be setting standards if NBS does not get into the biotechnology business? Has FDA or the Department of Agriculture encouraged NBS to become active in biotechnology?

ANSWER: The presence or absence of regulations is not dependent on NBS actions. NBS develops measurement standards for ensuring measurement reliability. Industry, regulatory agencies, and the U.S. voluntary standards system will use these measurement standards in whatever they do to ensure accuracy of measurements - this would include regulations. Regulatory measurements may be made with many different instruments. In general, this often leads to large variability in measurement results and costly disagreements between the regulator and the regulated. NBS measurement standards serve as the only objective basis for achieving comparability of results, reducing costly error in measurements. As stated in the NBS Planning Report: "A National Program of Measurement Services and Standards for Biotechnology at the National Bureau of Standards," March 1985, NBS services could be effectively used in support of the regulatory programs of the Department of Agriculture (USDA) and FDA. For example, NBS measurement methodology and standards could be used by the USDA to accurately detect the presence of toxic substances in various foodstuffs, and by the FDA to demonstrate the accuracy and reliability of data for product licensing through traceability to NBS standards.

In general, regulatory agencies and non-regulatory agencies turn to NBS for assistance in measurement. NBS officials have encountered universal enthusiasm with plans to develop measurement standards, paralleling services NBS has developed in other technology areas.

Questions for Dr. Johnson

PROCESS AND QUALITY CONTROL MEASUREMENTS

QUESTION 1: Aren't many of the calibration laboratories served by this program owned and run by Fortune 500 companies or alternatively run for profit? Why then should this program be expanded with appropriated dollars rather than user fees?

ANSWER: Both large and small American industries have placed major emphasis on quality control and increased productivity and depend on NBS measurement services. Less than 25% of our customers are Fortune 500 companies.

A profit can be made using calibrations for quality control, so we charge for them. It is not possible to make a profit doing measurement research as the results must be made available to all if they are to be useful. A standard only works if everyone has access and uses it. This is a governmental function and will not be paid for by industry.

Current NBS resources are insufficient to improve and deliver services in established measurement areas (which we must continue) and at the same time develop new services to meet emerging quality control needs. Increasing complexity and cost of developing new measurement methods and standards require new resources.

QUESTION 2: How much would it cost to provide all the services that are on the priority list identified by a committee of industrial representatives? To what extent do they pay fees for this service and what costs do their fees cover?

ANSWER: The total cost of the measurement research and activities associated with the thirty technical projects on the priority list identified by a committee of industrial representatives was $13.5 million. The FY 85 appropriation of $0.56M will fund the first two projects on the priority list. The FY 86 budget request for $1.94M would cover three additional projects.

NBS is responsible for providing the research costs to develop and maintain a particular measurement service. The users of NBS measurement services pay for all costs associated with the production and delivery of the service to them. For example, the user pays for all shipping and handling costs, labor cost for the technician and/or scientist associated with delivery of customer product, and all costs associated with certification of reference materials, calibration, or transfer standards.

Questions for Dr. Lyons
NBS FY 1986 Authorization
February 26, 1985

BUILDINGS

QUESTION 1: Dr. Ambler's testimony stated that it was time for this area to be transferred to the private sector. What has NBS done to prepare for such a transition? Given the diverse nature of the building industry and the remoteness of the standards making process from the builder, who are the likely candidates to take over this work? Does NBS currently have any competition in this area?

ANSWER: We have informed various organizations such as trade associations, NIBS, NCSBCS, U.S. Chamber of Commerce, as well as organizations represented on the CBT Board of Assessment. It would be the province of the industry working with the appropriate state and local governments and entities to put together funding and working arrangements to take over future work. Building research is conducted at several universities, but we are not aware of any research directed toward standards development other than at NBS.

QUESTION 2: Will this program continue to the extent that third parties are willing to fund it? What are the prospects for such funding?

ANSWER: We cannot definitively state what the private sector and state and local governments will do. NBS, however, is not likely to run a program that is exclusively supported by outside funds.

QUESTION 3: What will happen to the major NBS buildings facilities such as the tri-directional facility if funding is cut for this program?

ANSWER: Facilities will be available for use by anyone meeting the criteria for the use of NBS facilities and willing to pay the full operating costs.

FIRE RESEARCH

QUESTION 1: What evidence do you have that the private sector is willing to pick up NBS's work in fire research? To what extent is this work likely to be picked up by industry groups that have a vested interest in showing that their products are not contributors to the toxicity of fire?

ANSWER: We do not as yet have any solid evidence that the private sector is willing to pick this work up. We do, however, expect that state and local governments would be the ones most likely to take up the responsibility. In any case, it seems unlikely that state and local governments or the private sector will volunteer to take on something that the Federal government continues to provide.

Questions for Dr. Lyons

FIRE RESEARCH

QUESTION 3: What arrangements have been made for the private sector to carry on the research of the Center for Fire Research? To what extent are the facilities of the Center unique? Will these facilities be made available to the groups succeeding NBS as the leaders in fire research?

ANSWER: We have helped organize and conduct a National Fire Research Strategy Conference last year with the National Fire Protection Association. The roles of the private sector and various levels of government were discussed and agreed to by the participants. A summary of the results of the Conference is attached.

SUPERCOMPUTER

QUESTION 1: We note that we expect the new computer to be operational by April 1, 1985. Does NBS have the technical and administrative staff on board to handle such a computer both in the home location and in the five other locations which will be tied in to the system? Will these individuals be assigned to the Mathematics program? If, so, why is that budget cut?

ANSWER: On April 1, 1985 NBS will begin Acceptance Tests of the new computer. A fully operational system will be available by September 30, 1985. NBS will be providing technical and administrative staff for the central site and the Boulder location only. Staff at the other remote locations will be provided by NOAA. NBS is currently funded to provide 56 FTE at the central computer site and 16 FTE at Boulder. These include both government and contractor staff. The vendor is supplying 3 FTE in the systems area. Sixteen FTE in the operations area will be on contract to NBS. NBS is in the process of hiring 20 FTE in 6 areas.

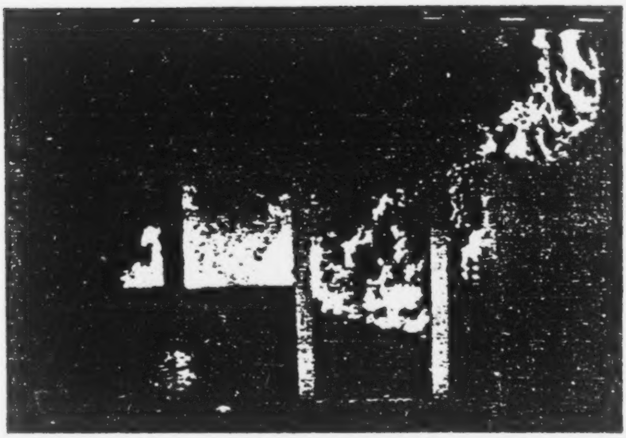
The staff for the Gaithersburg and Boulder sites will be assigned to the Center for Applied Mathematics, under the Computing Support portion of the Central Technical Support Subactivity.

The reduction in funds for Mathematical Sciences and for Computing Support are associated with the 5% federal pay cut, administrative cost reductions, and the Deficit Reduction Act of 1984. Reductions of this type affect all NBS programmatic areas.

NATIONAL FIRE RESEARCH STRATEGY CONFERENCE

BATTERYMARCH PARK
QUINCY, MASSACHUSETTS

AUGUST 28-29, 1984



A REVIEW OF THE NEED FOR RESTATEMENT OF NATIONAL GOALS AND DIRECTIONS FOR FIRE RESEARCH IN THE UNITED STATES

UNITED STATES DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington, D.C. 20234

NATIONAL FIRE PROTECTION ASSOCIATION
Batterymarch Park, Quincy, MA 02269
NFPA®

SECTION E

ACHIEVEMENTS OF THE CONFERENCE

In addressing the original intent of the meeting, the attendees analyzed and identified in some detail each of the five stated objectives for the conference.

While recommending that a wider involvement of interests will be required to develop a national strategy for fire research, the following is a brief summary of the overall conclusions reached in respect of each objective:

Objective No. 1: Assess the current status of fire research.

The current status of fire research is one of change and transition into promising new directions. Fire research is now at a critical point. Major advances are being made in capabilities to predict fire risk and appraise the impacts of design hazards or safeguards. The transfer of these advances to the fire protection community is just beginning.

Objective No. 2: Identify factors affecting progress in fire research.

Progress is being positively affected by the advent of new technologies and new approaches, but reduced financial resources for fire research are threatening such progress.

Objective No. 3: Review the technologies that are now available for fire research.

Technologies that can change fire research and produce effective solutions include, for example, physical systems for measurement of flame, gas production, and other combustion processes; powerful new generations of computers with vastly improved mass information-handling, analytical and interfacing capabilities; new capabilities for modeling and prediction of complex phenomena of fire growth and smoke movement along with behavioral patterns; responses of the humans and the performance of fire protection technologies, and important new technologies such as expert systems for effectively utilizing these tools and coupling them with researchers and practitioners.

Objective No. 4: Relate needs in fire research to capabilities to fulfill those needs.

Existing resources--trained professionals, facilities and funding--are limited. It is not yet clear these are sufficient. Nonetheless, significant advances can be made provided there is a coordination of effort involving an overall and dynamic plan in which all interests participate.

Objective No. 5: Recommend courses of action.

The course of action needed is clearly to involve all concerned in developing and implementing a national fire research strategy that addresses every aspect of fire research needs, resources and integrated action. This reflects the most important priority and the commitment of the participants of this conference.

Action Recommended

Those attending the National Fire Research Strategy Conference, having reviewed the current status of fire research; having examined many research needs, together with the availability of facilities and researchers; and having considered new and advanced technologies; resolved that the following statement be issued as a collective indication of intent to pursue the coordination of fire research in the United States:

A. A coordinated fire research plan should be developed to help achieve the reduction in fire losses in the United States in accord with the objectives of the Fire Prevention and Control Act of 1974.

The coordinated plan should encompass the following:

1. Development of an accurate identification of needs that is based on an inventory of completed or current research and prioritization of those areas requiring further investigation.

2. The Center for Fire Research fulfilling the crucial role of spearheading and coordinating basic and generic applied fire research - through independent research within the Center; by provision of grants, fellowships and technical support to independent researchers in universities and similar institutions; and by serving as an objective forum for reviewing and coordinating the national research effort.

3. Involvement of the academic community to take advantage of its scientific expertise and to assure a supply of scientists to carry on needed research into the next century.

4. Development of a plan to assure availability of the funding necessary to complete the required research. The plan should identify the potential benefits for both society at large and the specific interests of users of the research.

5. Means to effect transfer of research results to users such as engineers, designers, fire service and code officials and standards-developing organizations to permit implementation of the results for the public good in the shortest possible time.

6. Mechanisms to permit timely feedback from users to keep the plan dynamic and responsive to changing needs and capable of anticipating the effects of future technology where feasible.

B. That the National Fire Research Strategy Conference be continued and strengthened by the inclusion of others who have interest and concern in the matter of fire research and that with such infusion of additional expertise and support, it undertakes the development of the coordinated national fire research plan.

Questions for Dr. Lyons

ENGINEERING DATA

QUESTION 1: How does the United States compare with Japan and Europe in the evaluation of engineering data?

ANSWER: The United States leads the world in producing data bases. Other countries such as Japan, France, and Germany are moving aggressively in developing dissemination systems.

The United States and NBS in particular plays a strong leadership role in international efforts to standardize data bases and to coordinate data evaluation efforts. This includes NBS leadership in materials property data and other technical data work of CODATA - The International Committee for Scientific and Technical Data; chemical data base efforts of the International Union of Pure and Applied Chemistry; and physical property research of the International Association for the Properties of Water and Steam. These activities as well as others on the international scene will greatly expand the leverage of U.S. efforts and will increase the availability of foreign data to U.S. industry.

QUESTION 3: Why aren't these data bases being compiled commercially if the payoff for their implementation as in the corrosion area is in the billions? Is the NBS role a temporary one in getting the data base established?

ANSWER: The NBS role is not to market the data bases, but to develop new data bases and predictive models, to provide methodology for validating data bases, to standardize formats and terminology and to lead in the creation of a prototype dissemination system. The latter is a temporary role with the private sector eventually handling dissemination.

QUESTION 4: Will there be charges for use of the data bases? Will NBS recoup any costs from such charges? Will the data bases be readily available to our overseas competition?

ANSWER: There will be charges for use of the NBS data bases as provided for in the Standard Reference Data Act of 1972. This will allow NBS to recoup some development costs, but not the cost of creating the data bases, i.e. the cost of critical evaluation. As with other scientific creations of an intellectual nature our best protection from overseas competition is to ensure that we have developed the tools to make the most timely and efficient use of these creations in order to accrue maximum benefit to the nation. This is precisely what the NBS plan is attempting to do.

Assistant Secretary Merrifield's Answers to Written Questions on OPTI and NTIS Submitted by Chairman Walgren's House S&T Subcommittee

Q.1 Dr. Merrifield, everyone agrees that productivity growth and technological innovation play a critical role in U.S. economic growth and international competitiveness. At last year's hearings you stated that you "believed that OPTI is making a significant contribution in this regard." Why, then, is the Administration proposing that OPTI be abolished and what organization will take its place, if that is the case? Do you think that three people can adequately take care of this Nation's technological innovation and industrial productivity problems?

A. The Administration has strongly supported the need for increased productivity and technological innovation, and believes that the "catalytic" efforts undertaken by OPTI to stimulate private sector activity have been sufficiently successful that the OPTI functions can be attenuated. The overriding concern is to reduce the budget deficit by limiting governmental expenditures in OPTI to a small, ongoing coordination function, as described in my prepared testimony. Selected OPTI activities may be relocated to other organizations where that is feasible.

Q.2 If OPTI is abolished as proposed, what will happen to the metric program? At last year's hearings a letter from the President was read which stated that "The National Productivity Advisory Committee has recommended that the Federal Government continue to support conversion to metric measurement to enhance U.S. international competitiveness and hence productivity in several industries." Has there been a change in policy?

A. There has been no change in policy. The Department is reviewing options for the possible transfer of OPTI's metric functions to another unit in the Department. Examples of possible homes for this activity are the National Technical Information Services, the International Trade Administration, and the National Bureau of Standards.

Q.3 Small business firms are major developers of new, technology-based products and services; however, it is often difficult for them because they lack information on essential services such as financing and support programs. OPTI has provided those essential services in the past. If budget cuts are made, who will pick up the provision of those services?

A. If the SBA continues in some form, OPTI's small business activities logically might be included there, or perhaps combined with any SBA functions that might come to Commerce. A final determination should await a decision on SBA.

Q.4 OPTI's responsibilities include coordinating the formulation and implementation of policies for strategic resources, technology transfer and patent policy. If OPTI is abolished, who will pick up these responsibilities?

A. OPTI coordinates Federal policies for technology transfer and Federal patent policy. The Office of Strategic Resources is not part of OPTI.

The technology transfer and Federal patent policy functions are among those that may be absorbed by another Commerce unit.

The Office of Strategic Resources is a quite small coordinative activity. We believe its activities can be performed by other units in Commerce and in other agencies dealing with strategic resource matters.

Q.5 A great deal has been said about the need to utilize the research results of our federal labs. What do you see happening to the technology transfer effort if OPTI is abolished?

A. Legislation on this matter recently was introduced in both houses. We believe that OPTI will be able to provide any technical drafting assistance that the Hill might request on this legislation before OPTI is phased out, and this OPTI function may be continued elsewhere in the Department after the OPTI phase out.

Moreover, OPTI has developed an 'intern' program whereby key people from the private sector, small business development centers, and Federal laboratory personnel may learn sophisticated mechanisms for screening projects regarding probability of commercial success and for computer simulation techniques that quantify the strategic business variables involved. Our intent here is to place this particular capability in the private sector where it can be managed on an independent basis.

Q.6 OPTI has been actively involved with patent reform, what will become of the efforts that were started in the uniform patent policy legislation?

A. S.64 which addresses this issue of a uniform Federal patent policy was introduced earlier this year by Senator Dole. PL 98-620, passed late last year, assigns related regulation drafting authority to the Department of Commerce. We believe that most of the necessary work on this matter can be accomplished before OPTI is phased out. Further, we may continue this OPTI function elsewhere in Commerce.

Q.7 Your testimony states that OPTI's Industrial Technology Partnerships Program helped to stimulate over $2 billion of private sector R&D financing through the use of limited partnerships. What will happen to this program once OPTI is abolished?

A. Research and Development Limited Partnerships, which raised that $2 billion, have now become institutionalized in the private sector. This is a good example of a government initiative which has been successful in that the expertise and momentum for it have shifted to the private sector. Hence, there is no longer a need for a government program to encourage the RDLP mechanism.

Q.8 OPTI was a direct result of the Stevenson-Wydler Innovation Act of 1980, which will be coming up for reauthorization this year. If OPTI is abolished what organizational changes would you recommend to implement that legislation?

A. The Administration consistently has sought to carry out the intent and spirit of that Act. Examples of accomplishments are:

- Established the Office of Productivity, Technology, and Innovation under an Assistant Secretary.
- Performed various policy analyses and experiments
- Contracted out for a series of business assessment studies for a number of specific technologies.
- Established the Center for Utilization of Federal Technology (CUFT) under Section 11.
- Produced the required report on implementation of the Stevenson-Wydler Act for the President and Congress.

- o Successfully promoted use of Research and Development Limited Partnerships to attract private sector funding for cooperative research and development between business and nonprofit research institutions. Also, we supported passage of the National Cooperative Research Act of 1984, which should result in much greater private sector collaborative projects leading to major, breakthrough innovations, and which responds to the intent of Section 6 of the Stevenson-Wydler Act.

- o Made major advances in increasing the ability of industry to commercialize federally-funded inventions--coordinated the preparation of a Presidential Memorandum that establishes contractor ownership of inventions as the Government policy. Assisted enactment of P.L. 98-620, which extends that policy to the nonprofit operators of Government-owned laboratories, thus removing a serious barrier to commercial use of important inventions made in some of the largest federally-owned national laboratories. Developed a plan to accelerate commercialization of technology produced in government owned and operated Federal labs.

- o Established the National Technology Medal in accordance with Section 12. The President made the first awards in February of this year.

Some of the goals of Stevenson-Wydler have therefore largely been accomplished. Other Stevenson-Wydler functions may be assigned elsewhere in the Department once OPTI is phased out. At this time we are not proposing any organizational changes to deal specifically with Stevenson-Wydler implementation.

3/20/85

QUESTIONS FOR THE RECORD
NATIONAL TECHNICAL INFORMATION SERVICE

Q. If OPTI is abolished, as proposed, what plans have been made for NTIS? What plans have been made for the Center for the Utilization of Federal Technology (CUFT)? How will these changes affect the technology transfer program mandated by the Stevenson-Wydler Act?

A. NTIS would continue to report to the Assistant Secretary for Productivity, Technology and Innovation (PTI). It should be noted that OPTI (the Office of Productivity, Technology & Innovation) is one of the two units that report to the Assistant Secretary for PTI.

The Center for the Utilization of Federal Technology (CUFT) was established in 1982 as a part of NTIS. CUFT is not affected by the abolishment of OPTI since CUFT operates within the self-supporting mandate of NTIS. CUFT has two offices: the Office of Federal Patent Licensing (for Federally-owned technology) and the Office of Applied Technology (for Federally-originated technology).

The CUFT Office of Applied Technology performs the Stevenson-Wydler Act, Section 11 coordination and technology transfer functions. Its activities are divided into two parts: (1) Creation and sale of information products and data bases covering applied technology and promotion of patents for licensing; and (2) Coordination of agency and laboratory ORTA's, agency training in commercial potential evaluation, interagency conferences for industry, and preparation of interagency progress reports for the Congress and the President. It also is directly interacting with State technical assistance centers. Last year these centers were supplied with more than 1,000 copies of CUFT publications so that they would have the necessary information tools to link businesses with Federal technology.

The CUFT Office of Applied Technology carries out its functions using revenues generated by its information products and services. In FY 1985, up to $250,000 from sales of products and services will assure CUFT's ability to meet its Stevenson-Wydler commitment. In FY 1986, this office will continue to be operated from its product revenues and will also seek reimbursements from other agencies for services performed for them.

Therefore, the abolishment of OPTI is expected to cause no change in CUFT's ability to carry out the Stevenson-Wydler mandate.

Q. Would you please elaborate on the interaction of your organization with the Federal Laboratory Consortium.

A. As prescribed in the Stevenson-Wydler legislation, Section 11 (d), CUFT has worked on a continuing basis with the Federal Laboratory Consortium (FLC) to network the technology transfer activities of the individual Office of Research and Technology Applications (ORTA's) with State and local government, universities and the private sector.

An example of the CUFT efforts is the Directory of Federal Technology Resources identifying expertise, services, and facilities within the Federal R&D establishment. A second directory, Federal & State Contacts Involved with the Transfer of Federal Laboratory Technology facilitates contacts within the technology transfer community and is provided free of charge to all identified contacts.

CUFT and FLC are finalizing a Memorandum of Understanding to formalize areas of cooperative work. Possible areas of cooperation include; a) CUFT broker role to refer requests for assistance to the FLC to be networked with the appropriate laboratory; b) training sessions on CUFT information resources; c) CUFT programs to assist ORTA missions through market research information for screening and evaluating innovations, directories, catalogs and guides; d) personnel exchanges and training programs in patent licensing activities to provide the transfer of technology; e) increased ORTA activities in technology assessments to be reported by the CUFT Tech Notes; and f) CUFT/FLC cooperation to identify state economic development personnel to participate with CUFT/FLC programs to increase transfer of Federal laboratory technologies.

CUFT's recently intensified interaction with the FLC includes hosting the agency level liaison group meeting and the mid-Atlantic FLC laboratories meeting.

Q. During last year's authorization hearings the issue of the availability of Japanese scientific and technology information in the United States came up. Would you please describe NTIS's efforts in this area.

A. Agreements covering the acquisition of Japanese scientific and technical reports have been negotiated with 18 Japanese organizations, including MITI's research arm, the Agency for Industrial Science and Technology (JICST).

About 20% of the Japanese documents that NTIS is now acquiring as a result of these agreements are in English. The remaining documents are in Japanese, with about 75% of these documents having an English-language title and abstract. These are entered into the NTIS database and the abstracts are published in NTIS announcement media; copies are made available only in the original Japanese. NTIS is unable to use material which does not have at least an English abstract. Investigation into the use of machine-aided translation systems is underway.

NTIS has reached an agreement in principle with JICST to make eight Japanese science and technology databases available online in the U.S. The databases are currently entirely in Japanese. Two of them will be available partially in English in April 1986, and the English-language content is expected to increase progressively thereafter.

NTIS expects to have available for distribution in the Spring of 1985 a compendium of 60,000 citations of Japanese research projects in progress. This will be the first of an annual series. Distribution of a quarterly compilation of abstracts of Japanese publications on electronics will also begin in 1985.

An NTIS acquisition representatives is operating in Japan and NTIS has co-sponsored two conferences in the U.S. on Japanese science and technology information. We have recently entered into an agreement with JICST to co-host a U.S./Japan conference on scientific and technology information exchange (tentatively scheduled for April 1986).

Q. Secretary Baldrige recently complained in a letter to five top Administration officials that we are conducting a "massive giveaway program that permits the Soviets to acquire tens of thousands of scientific and technical studies as well as other strategic information." And that "Moscow has unlimited access to all information in NTIS through the All-Union Scientific Research Institute, a subscriber to this source of data." Do you have any recommendations on how to accomplish technology transfer to American business without "giving away" strategic information to the Russians?

A. It is important that all R&D sponsoring agencies, particularly NASA, DOD and DOE, continue to strive for standardized review and classification of scientific and technical information that is sensitive to the Nation's national security.

Application of standardized controls for marking technical reports prior to dissemination, coordinated with selected release of information to private contractors, should ensure continued technology transfer to American business without "giving away" strategic information to potential adversaries. Under these conditions the unlimited, unclassified, non-sensitive information will continue to flow to American business through the normal process established for information in the public domain.

As a result of policy directives from the Secretary of Commerce and the Assistant Secretary for Productivity, Technology, and Innovation, NTIS has maintained an embargo upon the sales of its products and services to the USSR and other Eastern European countries since early 1980.

It should be noted, however, that while we maintain this embargo, the export control laws do not contain any restrictions on the sale of NTIS products abroad. That is, any technical report which is for sale to the general public in the U.S., has a so-called general license for sale abroad without restriction. Thus, it is not unlawful for a third party to buy reports from NTIS and then ship them abroad, even to Russia. However, when NTIS is made aware that this is occurring, appropriate measures are taken.

Q. Would you please expand a little bit more on the two requested changes in NTIS' enabling legislation which is being presented in the Administration's bill? Specifically, the printing services by private firms and the authorization of capital asset acquisition or replacement.

A. PRINTING SERVICES:

NTIS performs or purchases a large volume of printing to satisfy paid customer requests. Due to the nature of the technical information and its importance to the scientific and technical community in preventing costly duplication of experimentation, NTIS must have the capability to print copies of reports in the shortest time frame at the lowest possible cost. Having the ability to procure private firm printing capabilities, directly and solely through the Department of Commerce, will give NTIS the ability to more closely monitor and control the timeliness, quality and cost effectiveness of its printing program.

CAPITAL ASSETS:

NTIS uses a trust fund to finance its operations. During a recent review by the General Accounting Office we were advised that neither our trust nor our enabling legislation authorized NTIS to purchase capital assets (equipment and inventories).

In order to make our authority to purchase capital assets explicit, we are requesting it be added to our organic legislation.

Q. Your testimony states that a request of $537,000 for the Patent Licensing Program was made for FY 1986. Is this an adequate amount to successfully fund this program?

A. The requested amount should be adequate to fund the present program. NTIS has recently received permission from OMB to retain certain cost-based fees which are charged licensees as part of their total licensing payments to the Government. Retention of these fees (an estimated $270,000 for FY 1986) will make up the difference between the appropriation request and total program costs.

○